CERTIFIED SOLDERING HANDBOOK

Mil-S-45743 Military Specification
Soldering, Manual Type, High
Reliability Electrical and Electronic
Equipment.

Mil-Std-1460 Military Standard
Soldering of Electrical Connections
and Printed Wiring Assemblies,
Procedure.

Reference From:
Department of the Army
Communication and
Electronics Material
Readiness Command

PROGRAM OF INSTRUCTION FOR
CERTIFIED SOLDERING ELECTRICAL CONNECTIONS

Preface

A. Course Title: Certified Soldering Electrical Connections

B. Purpose: To qualify personnel in inspection and repair personnel in current standards and inspection requirements for soft soldering electrical connections for missile and other weapon systems.

C. Prerequisites:

1. Prerequisite Entrance Examination: None

2. Work Background: Personnel should be in an assembly or inspection assignment, or have the "need to know" because of immediate or near future inspection requirements for such training. This course may also meet certification requirements of contractor solderers as specified in various Military Specifications.

3. Educational Background: Some high school or equivalent. Desire to learn about assembly and inspection.

D. Scope:

1. Develop the ability to apply current inspection procedures as well as application of proper techniques, tools, and materials according to the latest standards for soft soldering electrical connections for missile and other weapons systems. Successful completion of this training course will be dependent upon the trainee's performance in recognizing unacceptable work and to complete a number of solder exercises to meet the requirements of current soldering specifications. Graded samples of the trainee's solder workmanship will be kept on file for a period of twelve months at BEI Electronics, Inc., Fort Worth, Texas.

2. Safety and Plant Security: Covered as part of the course.

E. Length of Course: One Week, 40 hours

F. Security Clearance: None

Summary

Certified Soldering Electrical Connections

	Subject	Hours	Annex No.	Page
A.	Academic Subjects	38		
	Orientation, safety and security regulations, care and use of hand tools and equipment.	(2-1/2)	1	
	Solders and fluxes	(3)	2	
	Types of soldering equipment, and wire stripping and tinning	(4)	3	
	Soldering standards and inspection requirements	(25-1/2)	4	
	Review and examination	(3)	5	
B.	Non-Academic Subjects	2		
	Processing	(1)		
	Critique	(2)		
	Academic and Non-Academic Hours - Total	40		

Annex No. 1

Orientation, Safety and Security Regulations,
Care and Use of Hand Tools

(2-1/2 Hours)

Purpose: To have the students acquire a working knowledge of the course outline; safety procedures; security regulations; and care and use of hand tools and equipment.

Subject and File No.	Hours and Type	Scope of Instruction	References
Orientation, Safety and Security Regulations CS 1-1 (U)	1-1/2L	Description of course objectives and requirements and safety and security regulations.	POI and Safety and Security Rules and Regulations.
Care and Use of Hand Tools and Equipment CS 1-2 (U)	1 C,D	Description, care and maintenance of tools and equipment used in electronic assembly.	Instructor Notes.

Annex No. 2

Solders and Fluxes

(3 Hours)

Purpose: To have the students acquire a knowledge of the various solders and fluxes used in military electronic equipment.

Subject and File No.	Hours and Type	Scope of Instruction	References
Solders CS 2-1 (U)	2 C,D	Description of alloy mixtures: solid, pasty and liquid states; eutectic plus lead, eutectic plus tin; tests and application of solder alloy mixtures	Solder - Clifford Barber 00-S-571E MIL-S-45743 MIL-STD-1460(MU) Soldering Handbook B. M. Allen
Fluxes CS 2-2 (U)	1 C,D	Description of flux function; chemical compositions and reactions of soldering fluxes; flux residue removal; non-corrosive solvents.	LLL-R-626C TB-SIG-222 MIL-F-20329 MIL-S-45743 MIL-STD-1460(MU) Soldering Handbook B. M. Allen Solder - Clifford Barber

Annex No. 3

Types of Soldering Equipment, Wire Stripping and Tinning

(4 Hours)

Purpose: To have the students acquire a knowledge of the various types of soldering equipment, and wire stripping and tinning methods.

Subject and File No.	Hours and Type	Scope of Instruction	References
Types of Soldering Equipment CS 3-1 (U)	1 C, D	Description of types and maintenance of various types of conduction soldering irons; resistance soldering equipment; AC wattage ratings; types of soldering iron tips	W-S-570 F.S. TB-SIG-222 MIL-S-45743 MIL-STD-1460(MU)
Wire Stripping and Tinning CS 3-2 (U)	3 C, D, PE	Description of the various methods of insulation stripping, proper tinning of stranded and solid conductors; and the advantages of thermal wire stripping on small gage wires.	MIL-S-45743 MIL-STD-1460(MU)

Annex No. 4

Soldering Standards and Inspection Requirements

(25-1/2 Hours)

Purpose: To have the students acquire the ability to solder stranded conductor and component leads to various types of terminals; determine if solder connections are acceptable or unacceptable, and the use of proper equipment for the soldering operation.

Subject and File No.	Hours and Type	Scope of Instruction	References
Soldering Leads to Turret Terminals CS 4-1 (U)	6 PE	Develop skills in forming stranded wire and soldering component leads to turret type terminals to specification requirements.	MIL-S-45743 MIL-STD-1460(MU)
Soldering Leads to Bifurcated Terminals CS 4-2 (U)	5 PE	Develop skills in forming and soldering stranded wires to bifurcated (split) terminals via top and side routes and conforming to acceptable requirements.	MIL-S-45743 MIL-STD-1460(MU)
Soldering Leads to J-Hook type Terminals CS 4-3 (U)	5 PE	Develop skills in forming and soldering conductors to J-Hook connectors	MIL-S-45743 MIL-STD-1460(MU)
Soldering Leads to Cup Terminals CS 4-4 (U)	4-1/2 PE	Develop skills in the filling of a solder cup and soldering with the resistance soldering equipment.	MIL-S-45743 MIL-STD-1460(MU)

Annex No. 4
(continued)

Subject and File No.	Hours and Type	Scope of Instruction	References
Soldering Leads to Printed Circuit Boards CS 4-5 (U)	5 PE	Develop skills in soldering electronic component leads to printed circuit boards to obtain solder joints of high reliability, and to perform methods of rework.	MIL-S-45743 MIL-STD-1460(MU)

Annex No. 5

Review and Examination

(3 Hours)

Purpose: To review all soldering specification requirements and clarify any questions. To determine through examination, how much knowledge has been absorbed by the students.

Subject and File No.	Hours and Type	Scope of Instruction	References
Review CS 5-1 (U)	1-1/2 C	Review of all previous annexes, importance of requirements and the cost of one poor solder connection.	MIL-S-45743
Final Examination CS 5-2 (U)	1-1/2 E	Examination of all material covered in training course.	

Training Aids and References

A. Training Aids

1. 16mm Films

MF 9-9167	The Art of Soldering.	Boeing Aircraft
MF 9-9166	10-9-8-Hold.	Boeing Aircraft
	On Solder.	The American Electrical Heater Co.

2. 35mm Slides

B. References: The following publications were utilized in preparing course materials. All are cited in this POI. Copies are available for classroom and home study.

1. Military Publications.

MIL-S-45743 Soldering, Manual Type, Electrical Connections for Missile Systems, Procedures For

QQ-S-571E Soldering (Tin, Tin-Lead, and Lead-Silver).

MIL-STD-1460(MU) Soldering of Electrical Connections and Printed Wiring Assemblies, Procedure For

2. Non-Military Publications.

<u>Solder</u> - <u>Its Fundamentals and Usage</u>, Kester Solder Co.

<u>Soldering Handbook</u>, Multicore Solders, Ltd.

HOW GOOD AN INSPECTOR ARE YOU ?

100% inspection is not always 100% effective. As a demonstration of the effectiveness of 100% visual inspection, it is desired to determine the number of f' s in the following paragraph. Read through once and count the f' s.

The necessity of training farm hands for first class farms in the fatherly handling of farm livestock is foremost in the minds of farm owners. Since the forefathers of the farm owners trained the farm hands for first class farms in the fatherly handling of farm livestock, the farm owners feel they should carry on with the family tradition of training farm hands of first class farms in the fatherly handling of farm livestock because they believe it is the basis of good fundamental farm management.

Total Number of ________

SOLDERING SAFETY HANDOUT

As a part of your certification as an Operator, Inspector or Instructor, you will be required to observe the following safety rules. Safety properly practiced will protect you, your fellow students and the equipment entrusted to your care from damaging accidents that can be painful, costly and time consuming.

REMEMBER ACCIDENTS CAN BE PREVENTED.

MAKE A HABIT OF BEING SAFETY CONSCIOUS.

RULES

1. ALWAYS WEAR SAFETY GLASSES WHEN IN THE SOLDERING AREA.
2. DISCONNECT ALL ELECTRICAL POWER BEFORE WORKING ON A CHASSIS.
3. PLUG SOLDERING IRON INTO PROPER ELECTRICAL SOCKET AND KEEP PLUG FREE FROM STRANDS OF WIRE OR METAL.
4. PLACE SOLDERING IRON IN A LOCATION THAT WILL NOT REQUIRE REACHING ACROSS OR AROUND IT.
5. KEEP SOLDERING IRON IN HOLDER WHEN NOT IN USE.
6. DO NOT SPLASH SOLDER.
7. KEEP SOLDERING IRON IN UPPER CORNER OF WORK AREA WHEN NOT IN USE.
8. UNPLUG SOLDERING IRON WHEN PROJECT IS FINISHED OR AT END OF DAY.
9. VISUALLY INSPECT ALL EQUIPMENT AND TOOLS FOR DANGEROUS CONDITIONS.
10. WHEN CUTTING WIRES, KEEP THE OPEN SIDE OF THE CUTTER AWAY FROM THE BODY.
11. WHEN UNSOLDERING A WIRE, MAKE CERTAIN THAT THERE IS NO TENSION OR SPRING TO THE WIRE.

12. KEEP ALL YOUR WIRE PIECES IN YOUR WORK AREA.

13. PREVENT WIRES FROM OTHER WORK AREAS FROM ENTERING YOUR WORK AREA. (Flying Wires).

14. WHEN WORKING WITH FLAMMABLE SOLVENTS, KEEP A MINIMUM AMOUNT OF SOLVENT IN A SAFETY CAN.

    a. Do not smoke
    b. Do not spill solvent over work area

15. IN SOLDER POT USE:

    a. Do not place pot on wood surface - use steel, asbestos or other incombustible surface.
    b. Keep your eyes on your work.
    c. Keep water away from solder pot area.
    d. Make sure pot is safely placed on level surface away from workbench area.
    e. Never use solder which has been stored in a moist area.
    f. Always drag dross away from body.
    g. Watch loose hanging clothing.
    h. Avoid skin exposure to hot solder.

CLASSIFICATION OF
TIN-SILVER, TIN-ANTIMONY, TIN-LEAD,
LEAD-ANTIMONY, AND LEAD-SILVER SOLDERS

I. Classification

1. Type designation. The type designation shall be in one of the following forms:

Solid solder (no flux)

Sn60	W	S
Composition (2)	Form (3)	Flux type (4)

Flux-cored solder

Sn60	W	R	P2
Composition (2)	Form (3)	Flux type (4)	Core condition and flux percentage (5)

Solder paste

Sn60	P	R	A2
Composition (2)	Form (3)	Flux type (4)	Powder mesh size and flux percentage (6)

2. Composition. The composition is identified by a two-letter symbol and a number. The letters indicate the chemical symbol for the critical metallic element in the solder and the number indicates that nominal percentage, by weight, of the critical element in the solder.

3. Form. The form is indicated by a single letter, in accordance with Table 1.

TABLE I. Form

Symbol	Form
B	Bar
I	Ingot
P	Powder
R	Ribbon
S	Special 1/
W	Wire

1/ includes pellets, preforms, etc.

4. Flux type. The flux type is indicated by a letter or combination of letters, in accordance with Table II.

TABLE II. Flux type

Symbol	Flux type
S	Solid metal (no flux)
R	Rosin flux
RMA	Mildly activated rosin flux
RA	Activated rosin or resin flux
AC	Nonrosin or nonresin flux 1/

1/ includes acid, organic chloride, inorganic chloride, etc.

5. Core condition and flux percentage (applicable only to flux cored solder). The core condition and flux percentage is identified by a single letter and a number, in accordance with Table III.

TABLE III. Core condition and flux percentage

Condition symbol	Condition		
D	Dry powder		
P	Plastic		
Percentage symbol	**Flux percentage**		
	Nom	Min	Max
1	1.1	0.8	1.5
2	2.2	1.6	2.6
3	3.3	2.7	3.9
4	4.5	4.0	5.0
6 1/	6.0	5.1	7.0

1/ Not applicable to flux types R, RMA, and RA

6. Powder mesh size and flux percentage (applicable only to solder paste). The powder mesh size and flux percentage is identified by a single letter and a number, in accordance with Table IV.

TABLE IV. Powder mesh size and flux percentage

Size symbol	Powder mesh size	
A	325	
B	200	
C	100	
Percentage symbol	**Flux percentage**	
	Min	Max
1	1	5
2	6	10
3	11	15
4	16	20
5	21	25
6	26	30
7	over 30	

FLUX AND SOLDER APPLICATION NOTES
(QQ--S--571E)

I. NOTES

1. Intended use.

   a. Flux type.

      (1) Type R. Type R is intended for use in the preparation of soldered joints for electrical and electronic applications.

      (2) Type RMA. Type RMA provides a slightly more active fluxing action than Type R.

      (3) Type RA. Type RA provides more active fluxing action than RMA. It should be used only for soldering joints which are readily accessible so that the residues can be removed by cleaning agents and procedures specified in the governing document (drawing or specification) for the assembly in which the joints are used. Since the fumes and particulates given off during soldering may also be corrosive and contaminate the area surrounding the joint, this too must be susceptible to effective cleaning by the combination of materials and procedures to be used.

      (4) Type AC. Type AC is intended for use exclusive of that in electrical or electronic circuits in the preparation of soldered connections for all common metals or alloys, other than aluminum and magnesium and their alloys.

   b. Alloy compositions.

      (1) Sn96. Composition Sn96 is a special-purpose solder with a higher joint strength than tin-lead solders. It is intended for use in the food-processing industry because of its nontoxic characteristic.

      (2) Sn70. Composition Sn70 is a special-purpose solder where high tin content is necessary. It is intended for soldering zinc and for coating metal, etc.

(3) Sn63. Composition Sn63 is the tin-lead eutectic. It is used for soldering printed circuits where temperature limitations are critical and in applications where an extremely short melting range is required.

(4) Sn62. Composition Sn62 is a special-purpose solder widely used for soldering silver-coated ceramics.

(5) Sn60. Composition Sn60 corresponds closely to the tin-lead eutectic (see 6.1.2.3) and has a short melting range. It is preferred for soldering electrical or electronic connections and for coating metals.

(6) Sn50. Composition Sn50 is the customary "half-and-half" solder, intended for use in bit soldering sweated joints in plain, tinned, or galvanized iron or steel, copper and copper alloys, etc. It is for use with soldered fittings in copper water tubing.

(7) Sn40. Composition Sn40 can be used for the same purposes as composition Sn50, but is not as workable in bit soldering or sweating as is composition Sn50. Composition Sn40 is frequently used for dip soldering and as a wiping solder.

(8) Sn35 (see 6.1.2.16). Composition Sn35 is the customary wiping or plumber's solder. Higher antimony content in wiping solders promotes fine grain size and greater strength.

(9) Sn30 (see 6.1.2.15). Composition Sn30 is used as an automobile-body solder for filling dents and seams.

(10) Sn20 (see 6.1.2.14). Composition Sn20 is also widely used as an automobile-body solder for filling dents and seams, and for general purposes such as protective coatings on steel sheet where a high-tin-content alloy is not required.

(11) Sn10. Composition Sn10 is a solder with a high melting point and is intended for use in making electrical or electronic connections in high-ambient-operating-temperature equipments. Its uses are similar to those of the silver solders (see 6.1.2.17 to 6.1.2.19, inclusive) but it provides better resistance to corrosion under humid conditions.

(12) Sn5. Composition Sn5 is a solder used for applications similar to composition Sn10, but for applications having a slightly higher operating range.

(13) Sb5. Composition Sb5 is used for electrical or electronic connections subjected to peak temperatures of approximately 240°C, and for sweating copper-tube joints in refrigeration equipment.

(14) Pb80. Composition Pb80 is an automobile-body solder similar to composition Sn20, but with a lower antimony content.

(15) Pb70. Composition Pb70 is an automobile-body solder similar to composition Sn30, but with a lower antimony content.

(16) Pb65. Composition Pb65 is a plumber's solder similar to composition Sn35, but with a lower antimony content.

(17) Ag1.5. Composition Ag1.5 is used interchangeably with composition Ag2.5, but has a better shelf life and does not develop a black surface deposit when stored under humid environmental conditions.

(18) Ag2.5. Composition Ag2.5 cannot be satisfactorily applied on black, uncoated, steel sheet by any of the current soldering techniques. This composition requires higher soldering temperatures and the use of a flux having a zinc-chloride base to produce a good joint on untinned surfaces. A rosin flux is unsatisfactory for soldering untinned copper, or brass, or steel with this solder. This composition is susceptible to corrosion under humid environmental conditions.

(19) Ag5.5. Composition Ag5.5 will develop a shearing strength of 1,500 pounds per square inch at 177°C. When soldering hard-drawn brass or copper, the application temperature should not exceed 454°C. A typical application is on thermocouples for aircraft engines where relatively high operating temperatures will not affect strength of the solder. In other respects, precautions noted for composition Ag2.5 (see 6.1.2.18) also apply.

c. <u>Soldering of zinc and cadmium</u>. Inasmuch as zinc and cadmium appear to form inter-metallic alloys with the antimony in the solder, compositions Sn35, Sn30 and Sb5 should not be used for soldering zinc or cadmium, or zinc-coated or cadmium-coated iron or steel. These inter-metallic alloys have high melting points which inhibit the flow of the solder, resulting in brittle joints.

TEMPERATURE CONVERSION CHART

Conversion Method $^{o}F = 9/5^{o}C + 32^{o}$
$^{o}C = 5/9\ (^{o}F - 32^{o})$

°C	°F	°C	°F	°C	°F	°C	°F
-100	-148	+ 60	+140	+225	+437	+385	+725
- 95	-139	+ 65	+149	+230	+446	+390	+734
- 90	-130	+ 70	+158	+235	+455	+395	+743
- 85	-121	+ 75	+167	+240	+464	+400	+752
- 80	-112	+ 80	+176	+245	+473	+405	+761
- 75	-103	+ 85	+185	+250	+482	+410	+770
- 73	-100	+ 90	+194	+255	+491	+415	+779
- 70	- 94	+ 95	+203	+260	+500	+420	+788
- 65	- 85	+100	+212	+265	+509	+425	+797
- 60	- 76	+105	+221	+270	+518	+430	+806
- 55	- 67	+110	+230	+272	+525	+435	+815
- 50	- 58	+115	+239	+275	+527	+440	+824
- 45	- 49	+120	+248	+280	+536	+445	+833
- 40	- 40	+125	+257	+285	+545	+450	+842
- 35	- 31	+130	+266	+290	+554	+455	+851
- 30	- 22	+135	+275	+295	+563	+460	+860
- 25	- 13	+140	+284	+300	+572	+465	+869
- 20	- 4	+145	+293	+305	+581	+470	+878
- 15	+ 5	+150	+302	+310	+590	+475	+887
- 10	+ 14	+155	+311	+315	+599	+480	+896
- 5	+ 23	+160	+320	+320	+608	+485	+905
0	+ 32	+165	+329	+325	+617	+490	+914
+ 5	+ 41	+170	+338	+330	+626	+495	+923
+ 10	+ 50	+175	+347	+335	+635	+500	+932
+ 15	+ 59	+180	+356	+340	+644	+505	+941
+ 20	+ 68	+185	+365	+345	+653	+510	+950
+ 25	+ 77	+190	+374	+350	+662	+515	+959
+ 30	+ 86	+195	+383	+355	+671	+520	+968
+ 35	+ 95	+200	+392	+360	+680	+525	+977
+ 40	+104	+205	+401	+365	+689	+530	+986
+ 45	+113	+210	+410	+370	+698	+535	+995
+ 50	+122	+215	+419	+375	+707		
+ 55	+131	+220	+428	+380	+716		

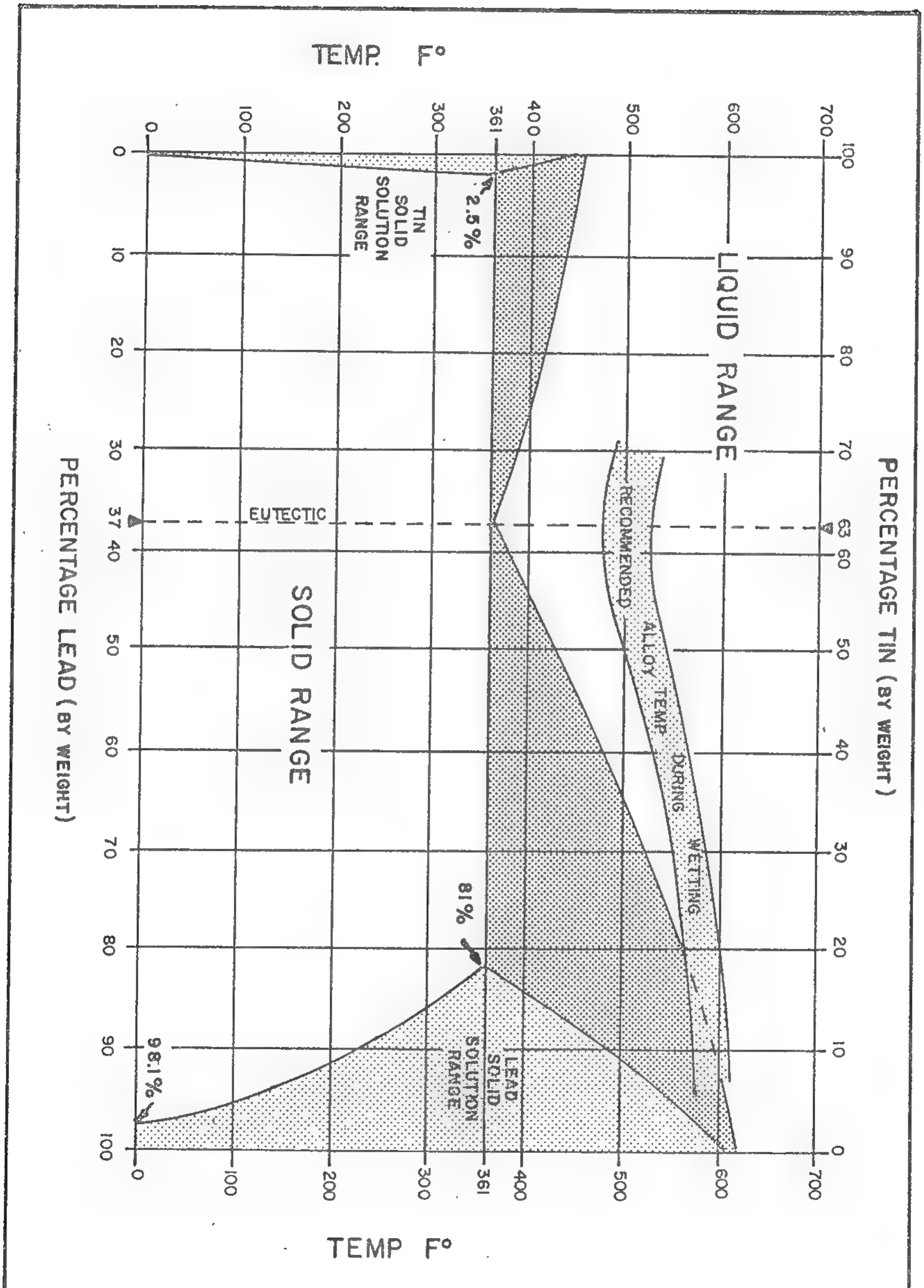
METALS

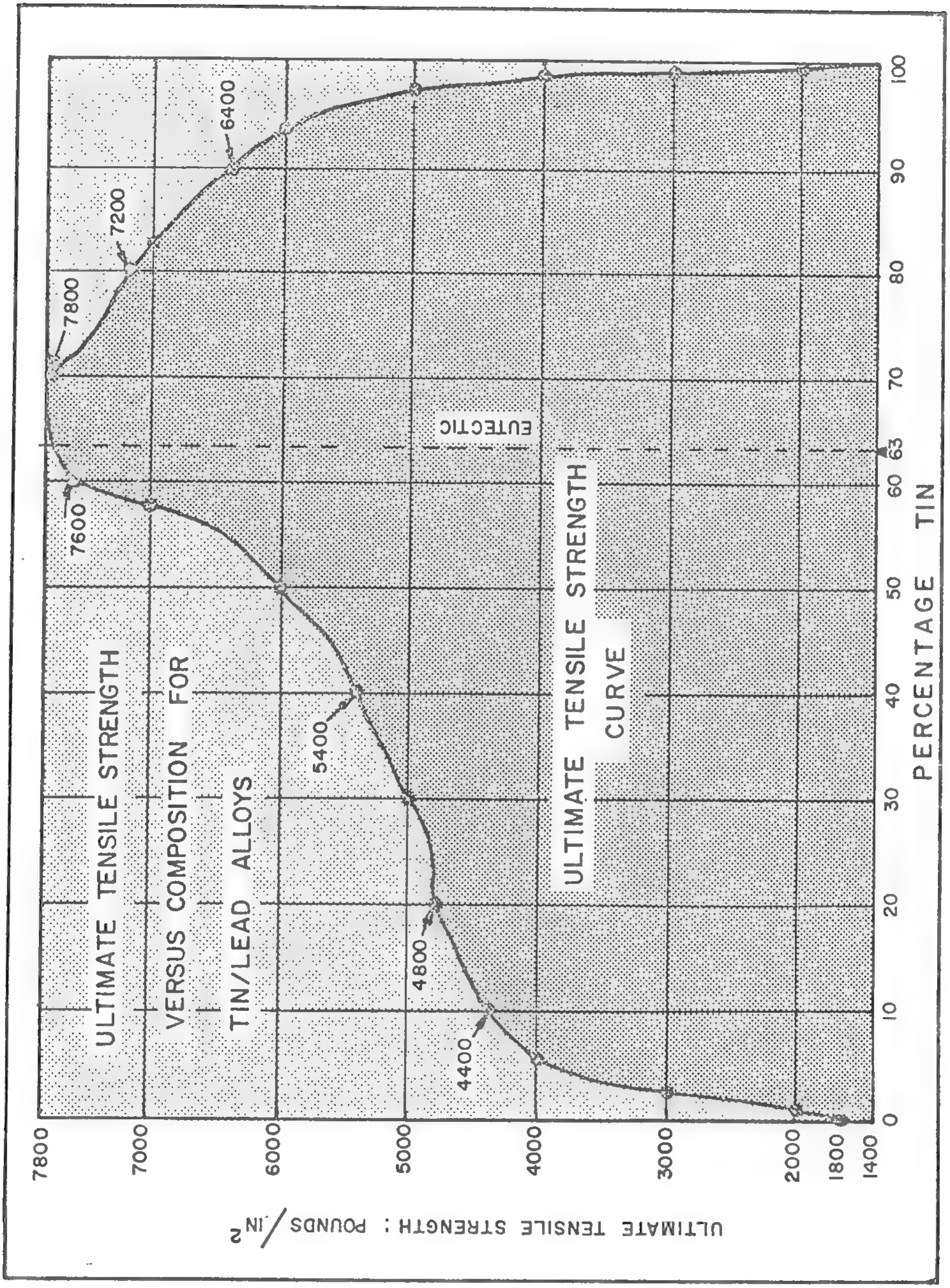
The modern electronics industry requires solder alloys that perform in service to give reliable joints. The alloy composition determines not only the melting point of the alloy but also the inherent soldering properties, the alloy strength and other characteristics. Conventional electronic solder alloys are in the tin content range of 50%-64%. The table below illustrates the standard grades of solder available from Fry Metals and their melting ranges. Fry Metals alloys meet or exceed the minimum impurity levels established by Federal Specification QQ-S-571 when applicable.

SOLDER ALLOY COMPOSITIONS

QQ-S-571

COMPOSITION	TIN	LEAD	ANTIMONY	BISMUTH (MAX)	SILVER	COPPER (MAX)	IRON (MAX)	ZINC (MAX)	ALUMINUM (MAX)	ARSENIC (MAX)	CADMIUM (MAX)	TOTAL OF ALL OTHERS (MAX)	APPROXIMATE MELTING RANGE SOLIDUS	APPROXIMATE MELTING RANGE LIQUIDUS
	%	%	%	%	%	%	%	%	%	%	%	%	°C	°C
Sn96	•	0.10 MAX	—	—	3.6 to 4.4	0.20	—	0.005	—	0.05	0.005	—	221	221
Sn70	69.5 to 71.5	•	0.20 to 0.50	0.25	.015	0.08	0.02	0.005	0.005	0.03	—	0.08	183	193
Sn63	62.5 to 63.5	•	0.20 to 0.50	0.25	.015	0.08	0.02	0.005	0.005	0.03	—	0.08	183	183
Sn62	61.5 to 62.5	•	0.20 to 0.50	0.25	1.75 to 2.25	0.08	0 02	0 005	0.005	0.03	—	0.08	179	179
Sn60	59.5 to 61.5	•	0.20 to 0.50	0.25	.015	0.08	0.02	0.005	0.005	0 03	—	0.08	183	191
Sn50	49.5 to 51 5	•	0.20 to 0 50	0.25	—	0.08	0.02	0.005	0.005	0.025	—	0.08	183	216
Sn40	39.5 to 41.5	•	0 20 to 0.50	0.25	—	0.08	0.02	0.005	0.005	0.02	—	0.08	183	238
Sn35	34.5 to 36.5	•	1.6 to 2.0	0.25	—	0.08	0.02	0.005	0.005	0.02	—	0.08	185	243
Sn30	29.5 to 31.5	•	1.4 to 1.8	0.25	—	0.08	0.02	0.005	0.005	0.02	—	0.08	185	250
Sn20	19.5 to 21.5	•	0.80 to 1.2	0.25	—	0.08	0 02	0 005	0.005	0.02	—	0.08	184	270
Sn10	9.0 to 11.0	•	0.20 max	0.03	1 7 to 2 4	0 08	—	0.005	0 005	0 02	—	0.10	268	290
Sn5	4.5 to 5.5	•	0.50 max	0 25	—	0.08	0.02	0.005	0.005	0.02	—	0.08	308	312
Sb5	94 0 min	0.20 max	4.0 to 6.0	—	—	0.08	0.08	0.03	0.03	0.05	0.03	0.03	235	240
Pb80	•	78.5 to 80.5	0 20 to 0 50	0 25	—	0.08	0.02	0.005	0.005	0.02	—	0.08	183	277
Pb70	•	68 5 to 70.5	0.20 to 0.50	0.25	—	0.08	0.02	0.005	0.005	0.02	—	0.08	183	254
Pb65	•	63.5 to 65.5	0.20 to 0 50	0.25	—	0.08	0.02	0.005	0.005	0 02	—	0.08	183	246
Ag1.5	0.75 to 1 25	•	0.40 max	0.25	1.3 to 1.7	0.30	0.02	0.005	0.005	0.02	—	0.08	309	309
Ag2.5	0.25 max	•	0.40 max	0.25	2.3 to 2.7	0.30	0.02	0.005	0.005	0.02	—	0.03	304	304
Ag5.5	0 25 max	•	0.40 max	0.25	5 0 to 6 0	0.30	0.02	0.005	0.005	0.02	—	0.03	304	380


TEMP. F°
PERCENTAGE TIN (BY WEIGHT)
LIQUID RANGE
SOLID RANGE
TIN SOLID SOLUTION RANGE
2.5%
EUTECTIC
RECOMMENDED ALLOY TEMP DURING WETTING
81%
LEAD SOLID SOLUTION RANGE
98.1%
PERCENTAGE LEAD (BY WEIGHT)
TEMP F°
0
100
200
300
361
400
500
600
700
10
20
30
37
40
50
60
63
70
80
90


ULTIMATE TENSILE STRENGTH
VERSUS COMPOSITION FOR
TIN/LEAD ALLOYS
ULTIMATE TENSILE STRENGTH
CURVE
EUTECTIC
PERCENTAGE TIN
ULTIMATE TENSILE STRENGTH : POUNDS/IN²
0
10
20
30
40
50
60
63
70
80
90
100
1400
1800
2000
3000
4000
5000
6000
7000
7800
4400
4800
5400
7600
7800
7200
6400

INFORMATION SHEET

DISSIMILAR METALS

1. Dissimilar metals are defined as metals which, when placed in contact with each other, will indicate an electrolytic potential difference (voltage) of greater than 0.4 volts when immersed in a 3% sodium chloride (salt water) solution.

Table I. Practical Electromotive Force Series

Magnesium
Magnesium alloy

Zinc

Aluminum

Cadmium

Steel
Iron

Lead
Tin
Soft Solder

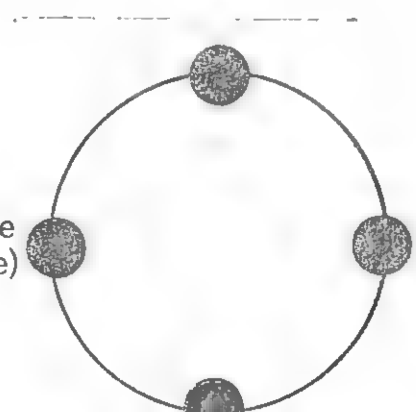
Nickel

Brass
Bronze
Copper

Silver

Silver

Gold
Platinum



2. Table I shows several small groups of metals. The further apart the groups are on the table, the greater the electrical difference between them and the greater the tendency to corrode when they are brought together in the presence of moisture. The metals lower on the list cause those higher on the list to corrode. Metals in the same group are considered similar for corrosion purposes.

SOLDER COMPOSITION

Composition - Parts that make the whole

Identification - Labeling parts that make the whole

Chemical Symbols - "Scientific shorthand"

Chemical symbols are used to identify solder composition

Metal	Chemical Symbol	Melting Temp.
Tin	Sn	450°F
Lead	Pb	621°F
Antimony	Sb	1166°F
Copper	Cu	1981°F
Cadmium (cast)	Cd	610°F
Silver	Ag	1761°F
Gold	Au	1945°F
Zinc	Zn	787°F
Bismuth	Bi	520°F
Aluminum	Al	1215°F
Calcium	Ca	1564°F
Nickel (cast)	Ni	2645°F

Government (Military) Identification - 2 letters plus one number

eg. - Sn 60

Commercial Identification - Usually 2 numbers and a slash

e.g. - 60/40

SIX FUNCTIONAL STAGES OF THE SOLDERING OPERATION

1. - Flux Melts

   a. - At temperature approximately equal to 300^{o}F
   b. - Must occur at temperature below solder alloy melting temperature
   c. - Flux prepares surface for molten solder

2. - Solder Melts

   a. - Happens at temperature determined by solder alloy only
   b. - Liquid state a must - solder becomes a solvent

3. - Solder Wets and Flows

   a. - Solder flows out over metals to be joined
   b. - Solder starts to adhere to solid surfaces to be joined

      Wetting: Liquid actually touching (adhering) to a solid surface

      Solderability: How easy is it to wet (solder) a surface

   c. - Higher tin content aids wetting action
   d. - Good wetting action shown by small contact angle concave fillets

4. - Solder Drawn Into Joint By Capillary Action

5. - Solder Alloys With Metals To Be Joined

   a. - Liquid solder dissolves some of base metal - solder a solvent (blending of the molecules)
   b. - A new alloy is formed
   c. - Quality of alloy (bond) determines strength of joint

6. - Solder Cools and Solidifies

FLUXES

Flux	Composition and/or Specification No.	Remarks
1. Rosin	Powdered, Spec LLL-R-626, Type II	Non-corrosive
2. Rosin-Alcohol	13% rosin, 87% alcohol, Spec MIL-F-20329, Type IV; or 13 lb. rosin in 9 gal alcohol	Non-corrosive
3. Rosin-Alcohol Shellac	A 15:1 mixture by volume of Rosin-Alcohol flux and shellac solution	Non-corrosive More active than rosin-alcohol
4. Rosin-Shellac-Alcohol	A 3:1 mixture by volume of Rosin-Alcohol flux and shellac solution	Non-corrosive More active than preceding flux
5. Rosin-Carbon Tetrachloride	0.7 lb. rosin per gal carbon tetra-chloride	Non-corrosive
6. Non-Corrosive Flux	MIL-F-20329; Types I, II, III, IV and V	Non-corrosive
7. Napthalene Tetrachloride	Equal parts by weight of napthalene tetrachloride and glycerine	Slightly corrosive: For untinned parts that cannot be washed with water
8. Soldering paste	Spec 0-F-506	Corrosive
9. Zinc Chloride-Alcohol	5-1/2 oz. of zinc chloride/gal of alcohol	Corrosive
10. Zinc Chloride Solution	20 lb. zinc chloride/gal of water	Corrosive
11. Soldering Salts Solution	3 lb. Soldering Salts (9:1 mixture $ZnCl_2$ and NH_4Dl) per gal of water.	Very corrosive

FLUXES
(continued)

Flux	Composition and/or Specification No.	Remarks
12. Zinc Chloride-Ammonium Chloride Solution	12 lbs. Zinc Chloride, 4 lbs. NH_4Cl, and 1 gal of water. Solution made acid to Litmus with HCl.	Very corrosive
13. Zinc Chloride-Sodium Chloride Solution	3 lbs. of $ZnCl_2$ - NaCl mixture (82:18) per gal of water.	Corrosive
14. Hydrochloric Acid Solution	2-1/2 volumes of HCl to 1 Volume of water	Very corrosive: Effective on small size nichrome wire, etc.
15. Zinc-Hydrochloric Acid Solution	Add Zinc Powder to zinc chloride-ammonium chloride solution.	Very corrosive: Use while gas is being evolved. Very good on nichrome wire, etc.
16. Hydrochloric Acid-Ammonium Chloride Solution	1 gal Comm'l HCl, 1 lb. NH_4Cl, and 1 gal of water.	Corrosive

FLUX WORKING

(How Flux Does Its Job)

1. Liquid vehicle evaporates - usually alcohol (liquid flux only)

2. Flux melts (280 to 300^{o}F)

3. Abietic acid released (about 310^{o}F)

   a. Does cleaning
   b. Approximately 80 to 85% of flux

4. Abietic acid dissolves oxides

5. Mixture formed -- copper abeitt

6. Mixture (copper abeit) covers metal surface

7. Solder melts

   a. 60/40 melts at 370^{o}F
   b. 63/37 melts at 361^{o}F

8. Heavier solder displaces flux and oxides

9. Solder wets clean oxide free metal surface

Requirements for MIL-SPEC Covered Flux

1. Must be non-corrosive
2. Must be non-conductive
3. Must be non-hygroscopic
4. Must have lower melting point than solder
5. Must not evaporate before solder flows
6. Must do some cleaning
7. Must be easily displaced by solder
8. Residue must be easily removed

CERTIFIED SOLDERING ELECTRICAL CONNECTIONS
FOR ROCKET AND MISSILE SYSTEMS COURSE
INSPECTION EXAMINATION

Name ____

Installation ______________________________________

Class No. ____________________ Date ____________________

Specification ____________________ Specimen No. ____________

Specimen ____

Term No.	Acc.	Rej.	Reason	Para.

Instructors ____________________

____

1. Grading of Finished Work.

NOTE: Student upon completion of first termination of conductor(s) will bring project to instructor for evaluation before proceeding further.

A. Evaluation by student and instructor for quality of workmanship.

B. Use 10 power magnification for inspection of all terminations.

C. Any one of the following defects shall be cause for rejection.

(1) Insulation burned or scorched
(2) Insulation does not have smooth even cut
(3) Wicking of stranded conductor
(4) Over or under twist of stranded conductor
(5) Incorrect insulation gap
(6) Broken, nicked, scraping, or ringing of the conductor(s)
(7) Flux residue
(8) Solder not neat, smooth or bright
(9) Solder coverage not 100%
(10) Contour of stranded conductor not visible
(11) Non-wetting
(12) No fillets
(13) Exposed copper
(14) Cold solder joint
(15) Overheated solder joint
(16) Excess solder joint
(17) Insufficient solder joint
(18) Rosin solder joint
(19) Fractured solder joint
(20) Solder spatters
(21) Solder bridges
(22) Heat damage to adjacent areas

NOTE: 1. There is no substitute for quality

2. The assembler is the first inspector to see his/her work and knows better than anyone the quality of the work.

GOLD PLATED PRINTED CIRCUIT BOARDS

A pull test to determine the strength of soldered connections on gold plated and unplated copper printed circuit boards was made at Redstone Arsenal, AL on 22 September 1961. The results of this test are as follows:

The action of molten solder on a metal surface may be compared to the action of water on a block of salt; the solder secures attachment by dissolving a small amount of the metal being soldered, then penetrates its surface. The attachment is formed by a chemical action, rather than a mere physical adhesion. The original solder is mixed with a small amount of the other metals to form a new alloy. This condition is referred to as intermetallic or solvent action. The degree of this solvent action determines the quality of the completed connection.

A reliable solder connection will have a bright finish, with a thin cover of solder revealing the contour of the component leads. It will also be feathered out with fillets of solder where the two metals have been joined together.

When solder connections are made on a gold plated printed circuit board, proper intermetallic action does not occur. The solder will have porosity and a built-up appearance. Large areas where the solder has not flowed properly will also be present. The solderability of gold plated boards are very poor, resulting in poor electrical connection, and in some cases, complete discontinuity.

Copper plated boards do not exhibit the same characteristics as the gold plated boards. When connections are made on copper, the solder does not have porosity, and there is excellent binding, and the solder penetrates the surface of the copper, resulting in a reliable electrical connection.

To test the relative strength of soldered connections, 20 component leads were soldered to each board, using a tin lead coated component lead material. The boards were attached to a stress pull machine, and each component lead was pulled until it separated from the connection.

Following are the results of the test performed on gold plated boards. All connections separated where the solder joined the etched circuit pad. The solder remained attached to the component lead. Only a small portion of the solder remained, leaving a tinned appearance on the pad. It can be concluded from this condition that intermetallic action did not take place.

GOLD PLATED PRINTED CIRCUIT BOARDS (continued)

The strength of the connection, as measured on a Dellon Multi Low Range Tester, revealed that the strongest connection separated from the gold plated circuit with a force of three pounds. The weakest connection separated with a force of 1/2 pound. The 20 connections separated with an average force of 1.8 pounds.

The copper board was tested in the same manner, however, there was a marked difference in the way the component leads separated from the connection. The solder on all 20 connections remained firmly attached to the etched circuit. The leads separated from the solder, leaving a groove where the leads had been pulled away. From this observation, it can be concluded that there was an intermetallic action between the solder and the metal being soldered.

The component leads were pulled from the copper board in the same manner as the gold boards. The leads on the strongest connection separated with a force of 5.9 pounds, the weakest connection separated with a force of 3.2 pounds. The 20 connections separated with an average force of 4.2 pounds.

It was further noted that the component leads, when pulled from the copper board, had evidence of stress, whereas the leads of the gold board had a tendency to pop off with no evidence of stress.

From these tests it can be concluded that unplated copper circuits have superior solderability and overall reliability.

DEFINITIONS OF SOLDER JOINT DEFECTS

1. Cold Joint: Contrary to the many publications and specifications dealing with solder connections, a cold joint does not necessarily have a dull, chalky, or granular appearance. This description more nearly describes a fractured or overheated joint. A cold joint results from insufficient temperature of the soldering iron tip or failure of the assembler to allow the terminal or connection to reach the correct temperature before applying solder. The size or mass of the terminal or connection should be considered in choosing the correct wattage soldering iron. (A cold joint will appear full, round, piled up, and will usually be shiny). The solder will not have the characteristic feathered out low fillet of a good joint.

2. Overheated Joint: The joint will appear dull, chalky and granular. This condition is caused by excessive iron temperature, allowing the iron tip to remain on the connection too long, or remelting the connection several times.

3. Fractured Joint: This joint will resemble the dull, chalky or granular appearance of the overheated joint but in addition will have a crack between the conductors. This condition results from moving the wire or conductor before the solder solidifies.

4. Improperly Bonded Joint: This joint will usually have a demarcation line between the conductors. This condition is often caused by oxidized, dirty, greasy, or otherwise contaminated conductors or component leads.

5. Pitted or Porosity Joint: This joint will show evidence of pits, pin holes, or small craters in the solder. This joint can be caused by oxidization, the type of plating material used on conductors (gold plating will cause this condition) or other foreign matter not compatible with solder. The joint may also appear dull, depending on the amount of contamination present.

6. Excess Solder: The contour of the wire or conductor will be covered by solder to the extent that a visual inspection will not determine if a proper bond has been achieved.

7. Insufficient Solder: Conductors with insufficient solder will have the appearance of being tinned and "sweated" together with no apparent fillet. A joint should have sufficient solder to produce a low fillet between conductors.

1. Barrel & Nut Assembly

2. Tip Assembly

2a. Working Surface (Flat or Contoured Area)

2b. Sensor End (Temp. Identification Example 6=600°) Crimped Over Tip Shank

3. Heater Element Housing Assembly

3a. Heater Element (Within Housing & Outside of Tip Shank)

3b. Switch (Activated By Tip Sensor, Enclosed Contacts)

4. Handle Assembly

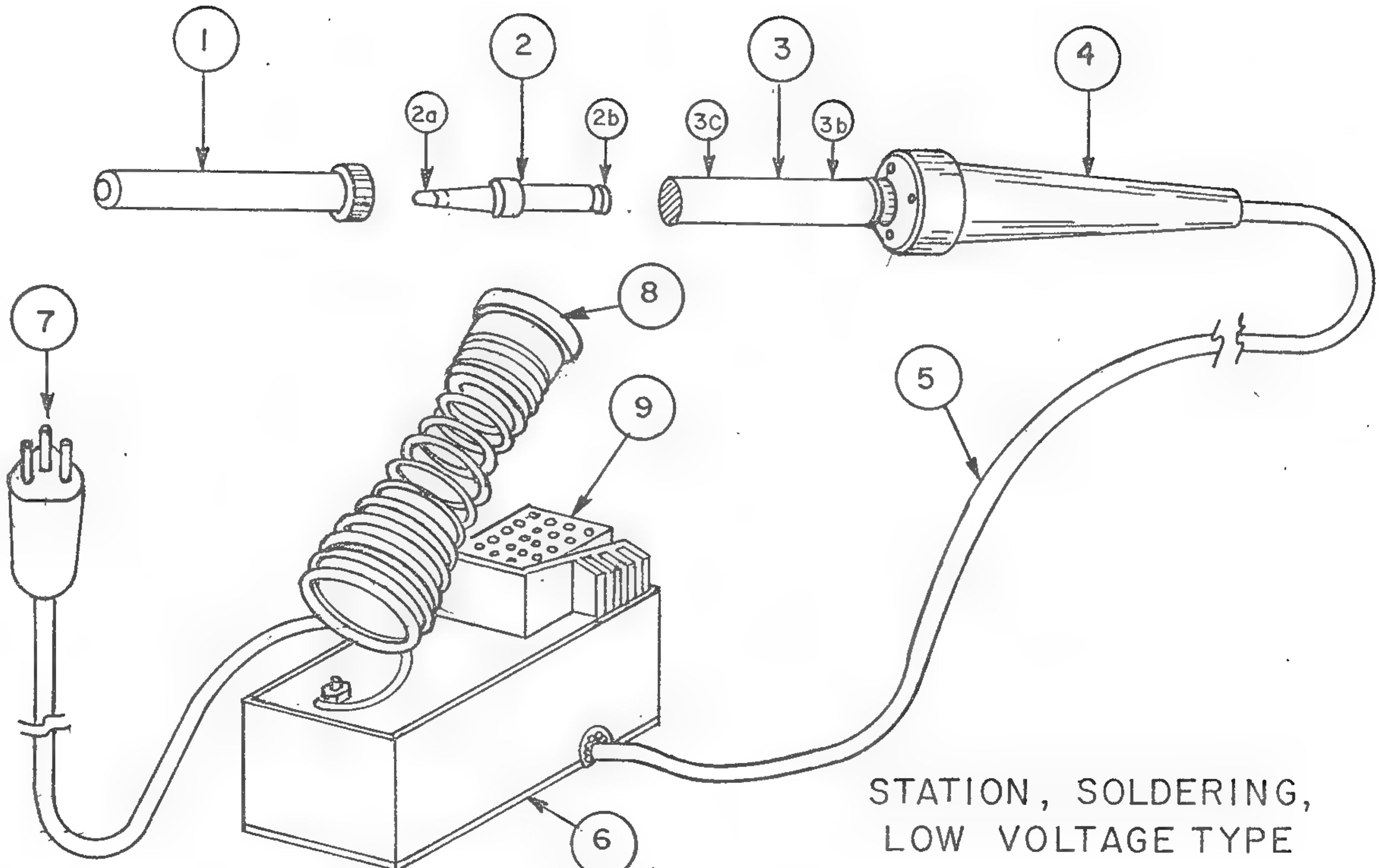
5. Low Voltage Wire (3 Conductor, 1 Ground W Silicon Jacket)

6. Transformer (120V to 24V, 60 Watt)

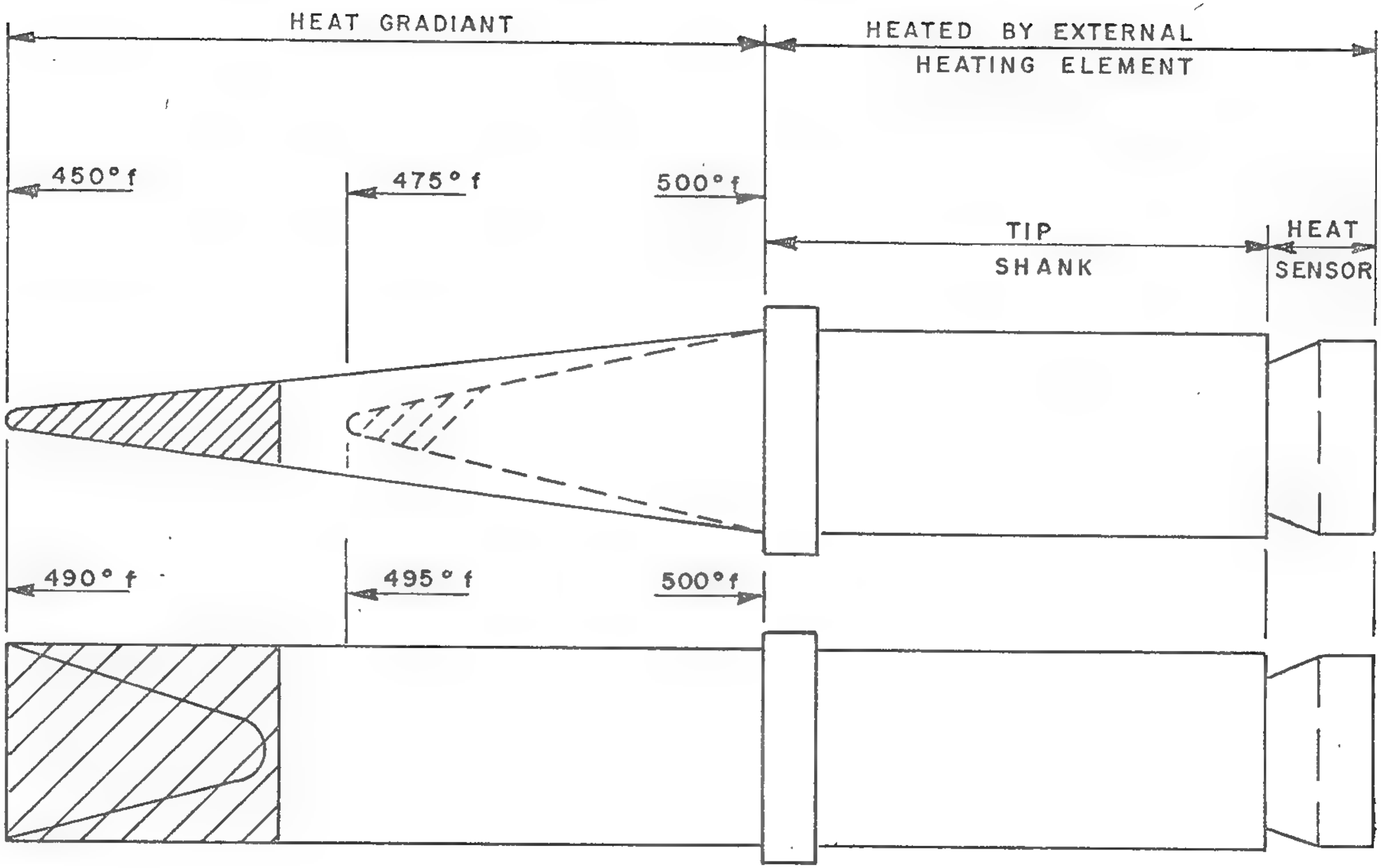
7. Power Cord (3 Wire "U" Ground)

8. Holder, Iron (Non Heat Sinking)

9. Sponge (Wetable For Tip Cleaning)

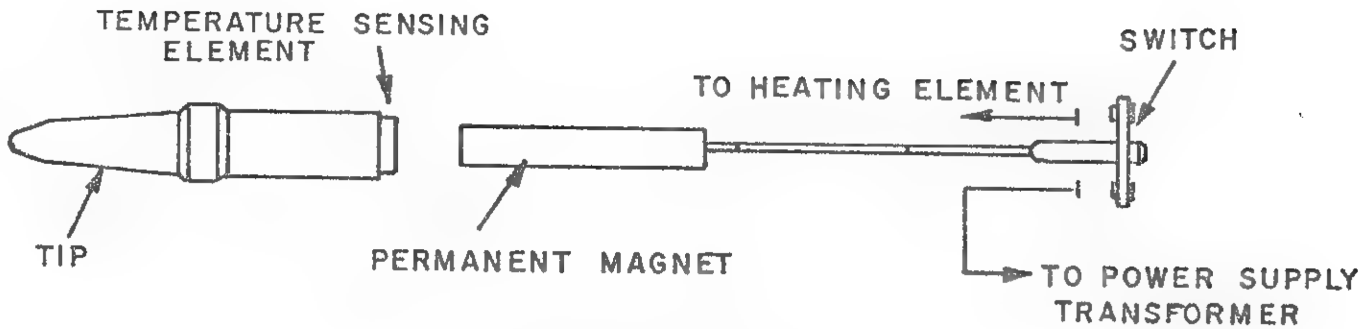


STATION, SOLDERING,
LOW VOLTAGE TYPE



TIP, SOLDERING

TEMPERATURE SENSING SYSTEM

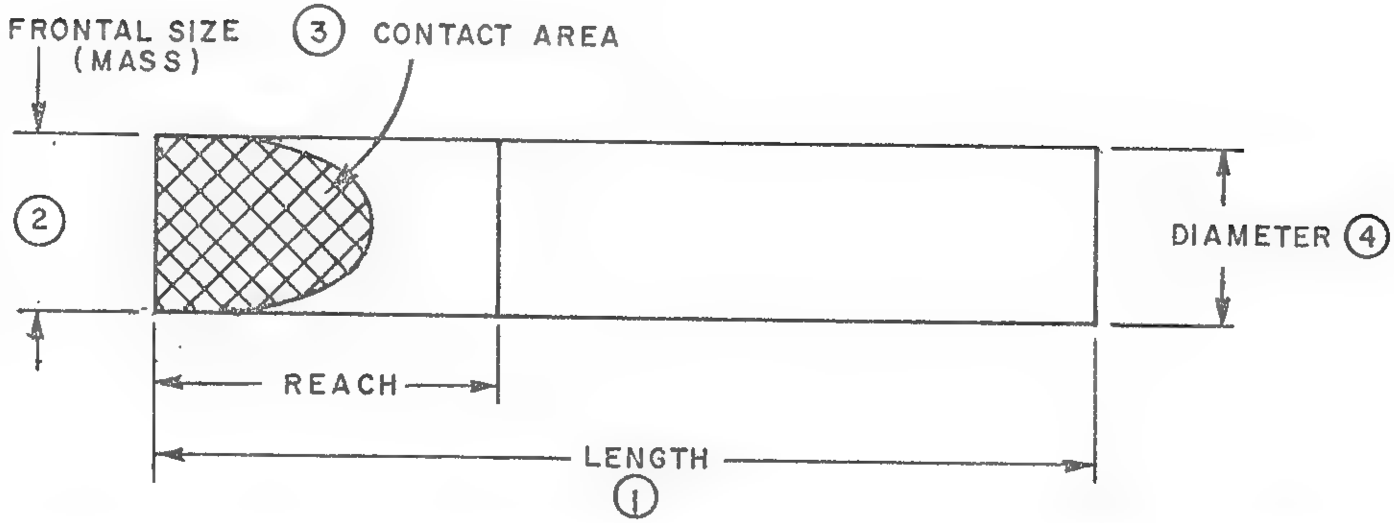


HOW THE SYSTEM WORKS

Permanent magnet is attracted to temperature sensing element when tip is cold. This pulls on power switch. As tip reaches its curie point, which is the pre-selected temperature of the tip, the temperature sensing element is no longer able to hold magnet. The magnet retracts, pushing the switch off. When tip cools slightly, the temperature sensing element again attracts permanent magnet to resume heating.

*Curie Point: Temperature below which substance is magnetic, above which substrate is non-magnetic.

DEPARTMENT OF THE ARMY
FRANKFORD ARSENAL
PHILADELPHIA, PA 19137



Consider Tip Design - To insure maximum transfer of heat, greatest rate of productivity and reliable connections at minimum cost keep:

1. Length - short as possible - increased efficiency - least loss of heat.

2. Frontal Mass - large as possible - good heat retention (avoid turned down tips).

3. Contact Area - match shape to work surface - best transfer of heat (keep taper as short as possible).

4. Diameter - keep large as possible - best storage of heat.

5. Materials - Choose for reduced maintenance costs, best heat conduction and heat conduction and heat retention.
   a. Copper - good heat conduction and retention; high maintenance costs.
   b. Copper clad - poorer heat conduction, good heat retention, low maintenance costs.

DIP POT AND BATH SOLDERING

1. Both manual and automatic
2. Pot serves as both heat source and solder supply
3. Work must be prefluxed. Uses type S - Form "B" or Form "I"
4. Controlled dip and removal allows gravity and temperature to control amount of solder adhering to a surface.
5. Exposed surface will oxidize (dross); skim before dipping.
6. Uniform solder temperature caused by natural convection. (Heater coil on bottom).
7. Excessive impurities will cause grainy brittle surfaces.
8. Good ventilation will carry off offensive odors and harmful fumes.

RESISTANCE SOLDERING

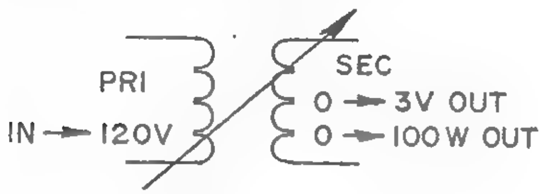
1. Definition: Where heat is produced by, resistance of work to current flow through it.

2. Basic parts:

   a. Foot switch - controls on/off time of unit
   b. Power unit - (Wasco Glo-Melt 105-A3)

      (1) Steps voltage down

         (a) 120 volts in - primary
         (b) 0 - 3 volts out - secondary
         (c) 0 - 100 watts out



         (d) Steps current up
         (e) Dial allows changing output

   c. Handpieces

      (1) Holds and places electrodes in contact with work

      (2) Single and dual electrodes

      (3) Types: Tweezer, pencil -- plier, fork
                 (light duty)   (heavy duty)

   d. Electrodes

      (1) Carbon - higher current, single electrode use

      (2) Metal alloy - higher tensile strength dual electrode use

   e. Thermal strippers: uses heat to sever insulation

3. Advantages

   a. Instant heat - no warm up

b. Adequate heat - high current available

c. Controlled heat

   (1) Degree - amount (dial)

   (2) Period - time (foot switch)

d. Isolated heat - only where you want it

SOLDERING IRON

1. Use - generates and stores heat which is transferred to work by conduction.

2. Basic parts

   a. Plug and cord - path for current flow
   b. Handle - protects operator from heat
   c. Heating element - high "R" winding; generates heat
   d. Tip - transfers heat to work

3. Iron design (important parameters)

   a. Wattage - measure of energy produced by heating element
   b. Maximum tip temperature (idling temp.) - maximum steady state, no load, tip temp. (when the heat given up by the tip equals the heat furnished by the core or heating element. (Must be able to bring the joint to soldering temp. in req. time).

   c. Recovery time (rate) - time required to regain energy lost to the (A) load

   d. Efficiency - ratio of energy produced to energy available at work

4. Tip design (important parameters)

   (   ) - (refer to handout in handout booklet)

5. Tip maintenance

   a. Dress as needed - copper only

Before

After

dissolve ≠ melting
tin biggest culprit

   b. Use anti-sieze on threads - reduce scaling
   c. Keep tips clean and well tinned
   d. Use emory cloth on iron clad tips; Do Not File
   e. Make sure all tips are well seated...(Fully in iron)
   f. Keep sponge wringing damp
   g. Keep iron in holder

GLOSSARY OF SOLDERING TERMS

1. Adhesion - Force of attractions between unlike molecules.

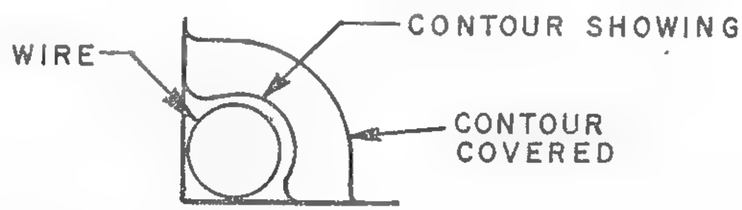
2. Alloy - A mixture of two or more metals (Ex. tin and lead).

3. Birdcaging - Opening up of individual strands of wire usually caused by reverse twisting while stripping or bending conductors.

4. Capillary Action - The combination force, adhesion and cohesion, which causes liquids, including molten metals, to flow between closely spaced solid surfaces, even against gravity; causes wicking. (Ex. lamp wick, ink blotter, sugar cube).

5. Cohesion - Force of attraction between like molecules.

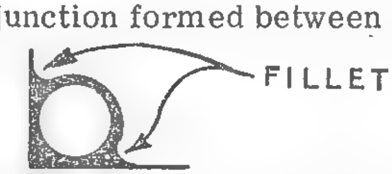
6. Contour Soldering - Applying solder so the outline of the conductor is visible after soldering.



7. Dross - The oxide scum present on the surface of molten solder baths or pots.

8. Eutectic Solder - Solder containing 63% tin and 37% lead: solder alloy with the lowest melting point (361°F): solder alloy having a sharp melting point (no pasty range).

9. Fillet - A concave junction formed between two mating surfaces.



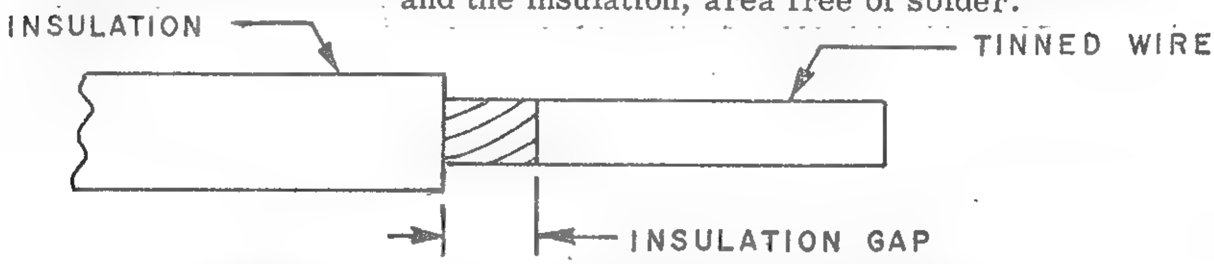
10. Flux - A liquid or solid reducing agent used to clean and prepare a surface to be soldered; any substance that promotes the fusion of two metals; any substance that aids the wetting action of solder which then improves solderability.

11. Fusion - melting and combining two different metals.

12. Hard Soldering - Joining two metals using alloys heated to a temperature over $800^{o}F$.

13. Heat Sink - A device, usually copper or aluminum, which clamps on a conductor to protect a component from excessive heat; also called a Thermal Shunt.

14. Insulation Gap - The space between the tinned portion of a wire and the insulation; area free of solder.



15. Intermetallic Action - The action where molten solder dissolves some of a base metal and forms a new metal containing both (Ex. solder and copper).

16. Liquid State - The state of solder when it is completely melted.

17. Oxidation - When molecules of oxygen in the air combines with surface molecules of base metals.

18. Oxides - The non-metallic film that forms on the surface of metals when oxygen molecules combine with molecules of the base metal.

19. Pasty Range - The condition of solder between the solid and liquid state; soft, mushy, pasty condition where liquid and solid crystals exist together.

20. Reducing Agent - An agent that removes the oxygen molecules from a substance.

21. Reliability - The probability that an item will perform its intended function for a specific interval under stated conditions.

22. Rosin - Hard, brittle resin, light yellow to almost black in color, remaining after oil of turpentine has been distilled from crude turpentine.

23. Soft Soldering - Joining two metals using alloys heated to a temperature under $800^{o}F$.

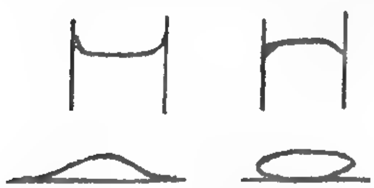
24. Solder - A fusible metal alloy, usually tin and lead, used to join two or more metals at a temperature below their melting points.

25. Solderability - The ability of a metal surface to be wetted by molten solder; capable of being soldered.

26. Stripping - Removal of wire insulation by mechanical, chemical, or electrical means.

27. Tinning - Coating of a surface with a thin uniform layer of solder.

28. Wetting Action - The intermolecular attraction between the solder and a base metal which then forms a new alloy. The adhesion of a liquid to a solid metal surface.

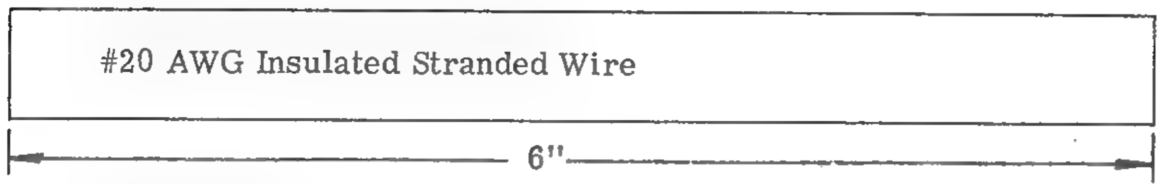


WETTING NON-WETTING

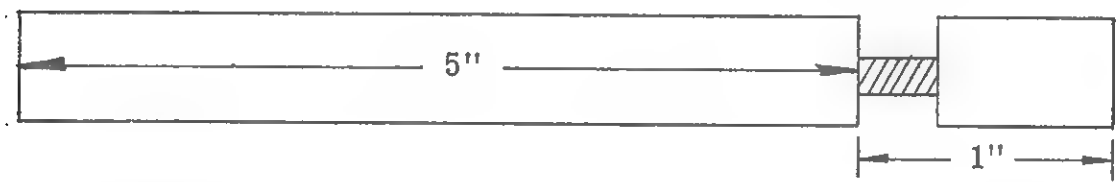
29. Wicking - Capillary action which causes solder to flow under the insulation of stranded wire.

CERTIFICATION PROJECT PROCEDURE

Wire Stripping and Tinning



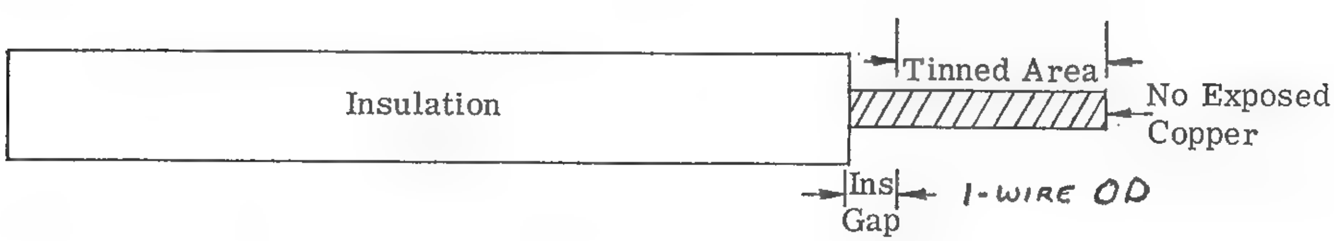
(1) Select 6 Wires
(2) Strip and tin one end only



(3) Strip 1"
(4) Use correct hole in factory set mechanical strippers
(5) Do not go through full cycle, sever insulation only
(6) Remove insulation with fingers, not tool
(7) Remove insulation with twist in direction of lay of wire

(8) Inspect stripped wire for:

a. Damage to wire or insulation
b. Disturbed lay of wire
c. Clean even cut in insulation

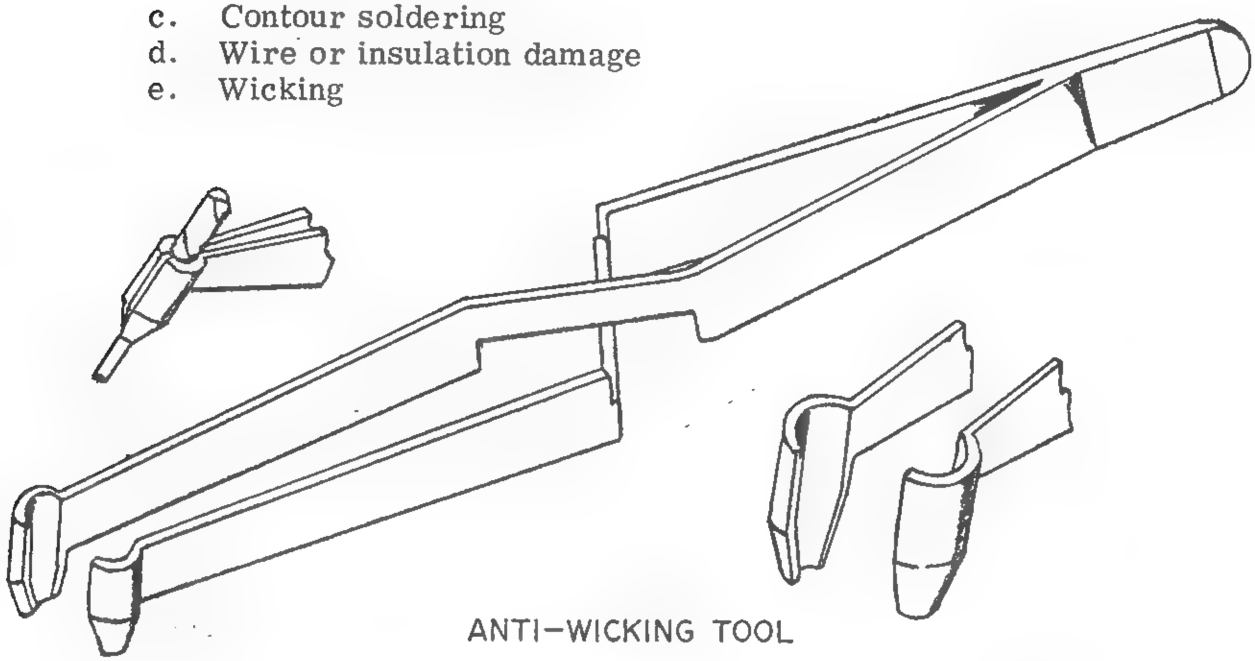


(9) Solder - Use antiwicking tool or double cut method to prevent wicking

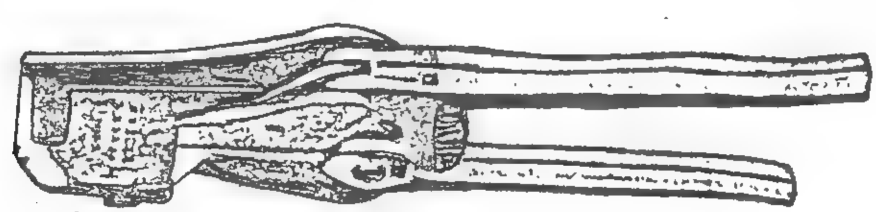
(10) Remove Flux Residue - Use approved solvent and tissue

(11) Inspect stripped and tinned wire for:

a. Exposed copper
b. Correct insulation gap = 1 wire OD
c. Contour soldering
d. Wire or insulation damage
e. Wicking

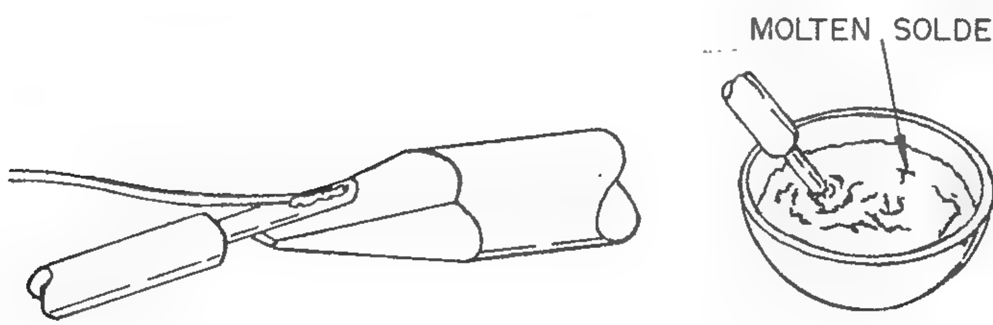


ANTI-WICKING TOOL



L-5211 PVC
L-5560 TEFLON

PROPER CUTTING-TYPE STRIPPER



SUGGESTED METHODS FOR TINNING (WIRE)

CERTIFICATION PROJECT PROCEDURE

SOLDERING STRANDED LEADS TO TURRET TERMINALS

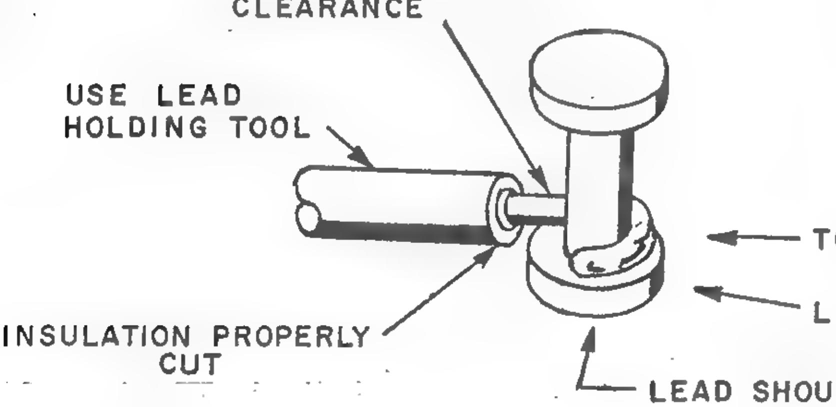
1. Strip, tin and clean 6 #20 AWG stranded wires.
2. Put terminal in proper hole in vise held teflon holding fixture.
3. Form leads; 180^{o} bend.
4. Cut formed lead to measured length.
5. Clean terminal

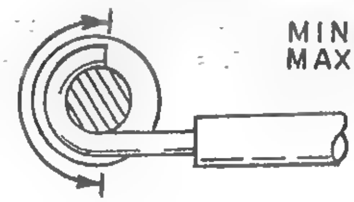
   a. Pencil eraser - remove oxides.
   b. Approved solvent - dirt, grease, residue.

PP13 1460 - 150° MIN. 270° MAX.

PP-9 45743 - 180° MIN. 270° MAX.

6. Make mechanical connection.

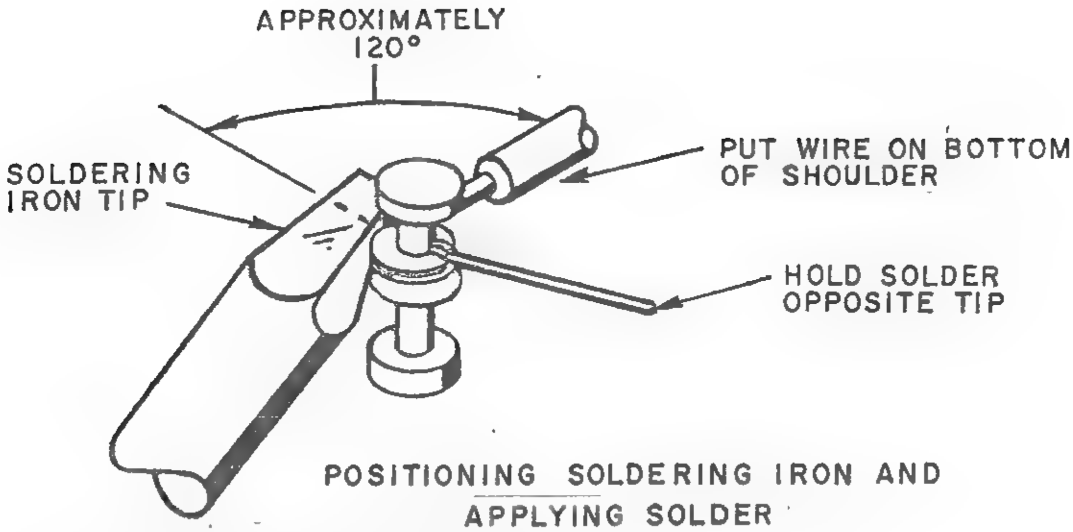




7. Apply heat sink.

Typical Thermal Shunts

8. Solder.



POSITIONING SOLDERING IRON AND
APPLYING SOLDER

a. Iron touches both lead and terminal
b. Apply solder 180° away and paint

9. Remove flux residue
10. Inspect for:

a. Contour soldering
b. Concave fillets between all mating surfaces
c. Smoothness - no rough surfaces
d. Neatness - no foreign matter
e. Shininess
f. Exposed copper
g. Compliance with applicable standards

11. Show instructor only that work that passed your inspection.
12. Put instructor approved work in project bag.
13. Project requirements are 6 acceptable connections.

BEG - FOR - HI - C

CERTIFICATION PROJECT PROCEDURE

SOLDERING STRANDED LEADS TO BIFURCATED TERMINALS

1. Strip, tin and clean 6 #20 AWG stranded wires.
2. Clean bifurcated terminal.

   a. Pencil eraser - oxides
   b. Approved solvent - dirt, grease, residue

3. Put terminal into vise held teflon holding fixture.
4. Using approved method form leads for correct mechanical bends.

NOTE: AVOID BIRDCAGING - Do not start bend in untinned area.

5. Using terminal measure and cut off excess wire length.
6. Attach lead to terminal - use approved wire holding tool.

7. Mechanical wraps should:

   a. Fit fork snugly
   b. Lay flat on shoulder
   c. Have proper insulation gap
   d. Conform to applicable Mil Standards

8. Apply heat sink
9. Solder

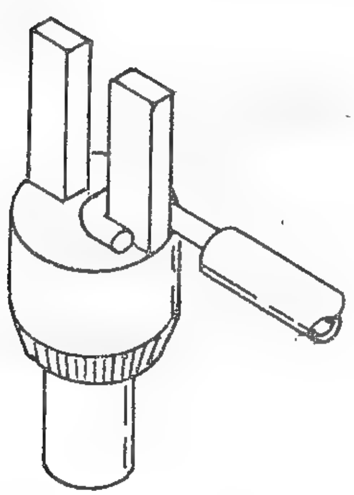
   a. Iron touching both lead and terminal
   b. Iron placed farthest from most heat sensitive component
   c. Solder applied 180^{o} away from iron

10. Remove flux residue
11. Inspect for:

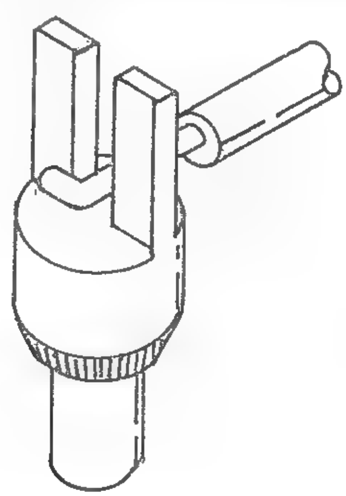
    a. Concave fillets between all mating surfaces
    b. Contour soldering
    c. Neatness - no foreign matter
    d. Smoothness - no rough surfaces
    e. Shininess
    f. Exposed copper
    g. Correct mechanical wrap

12. Have instructor inspect your acceptable connections.
13. Put instructor approved work in your project bag.
14. Project requirements:

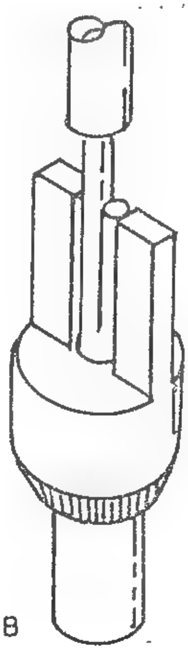
    2 acceptable 180^{o} bends
    2 acceptable 90^{o} bends
    2 acceptable - top entry double back bends



B
180° BEND PERMITTED



A
90° BEND PREFERRED



B

DEPARTMENT OF THE ARMY
FRANKFORD ARSENAL
PHILADELPHIA, PA 19137

CERTIFICATION PROJECT PROCEDURE

SOLDERING STRANDED LEADS TO "J" HOOK TERMINALS

1. Strip, tin and clean 6 pieces of #20 AWG stranded wire.
2. Clean each "J" hook

    a. Approved eraser or braid cleaner - oxides
    b. Approved solvent - dirt, grease, residue

3. Put terminal in teflon holding fixture.
4. Form leads: scale, pliers, lemon stick, etc.

    a. Three 180° bends
    b. Three 90° bends
    c. Cut to required length
    d. Reference insulation gap from top of terminal

5. Attach lead to terminal

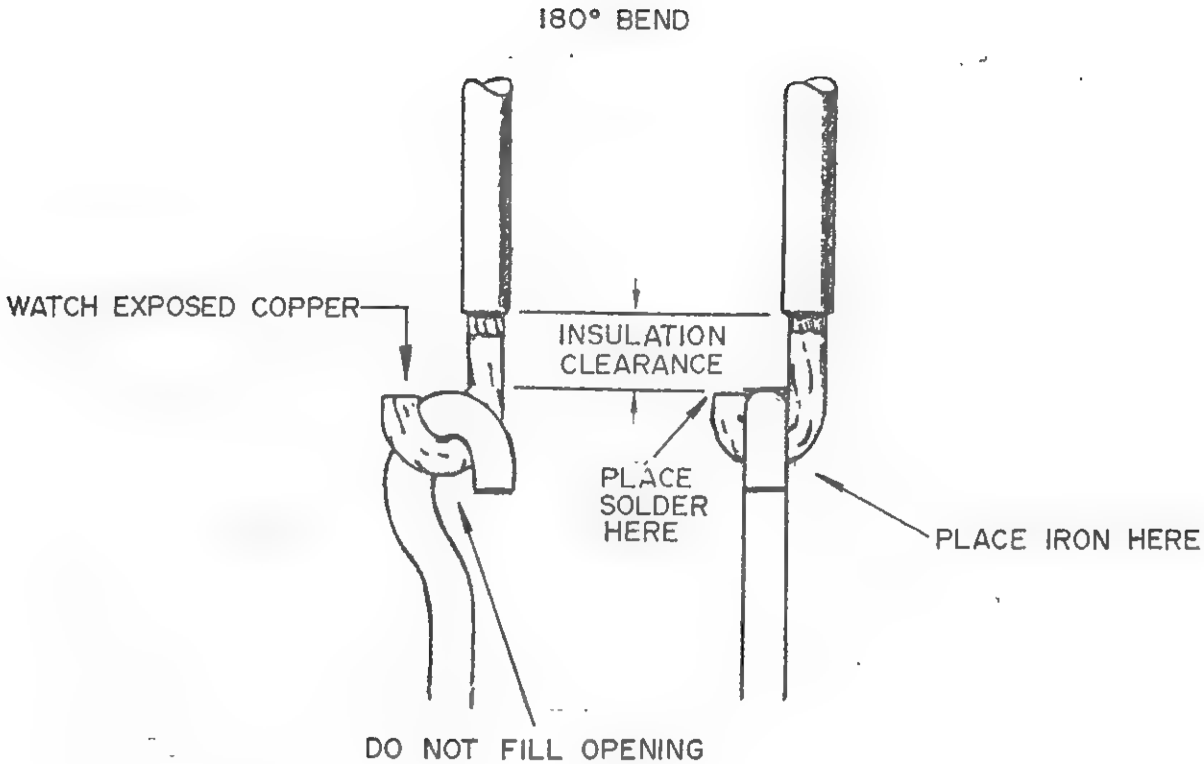
    a. Use wire holding tool
    b. Use heat sink

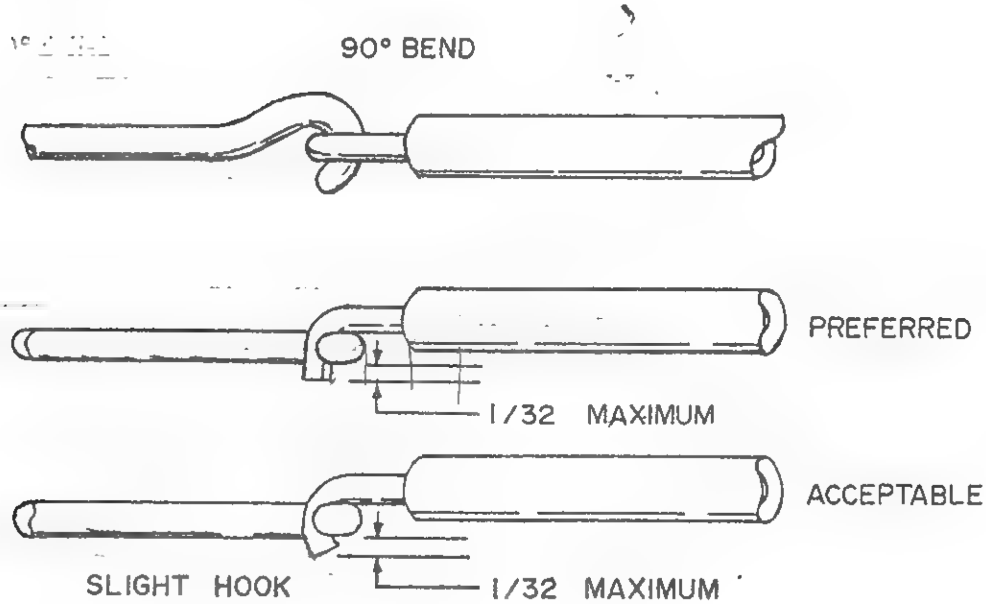
6. Solder

    a. Use smaller dia. solder
    b. Do not linger - avoid excessive solder
    c. Very little mass; watch tip temperature

7. Remove flux residue.
8. Inspect your own work.
9. Have instructor inspect work that has your approval.
10. Put acceptable work in project bag.
11. Project requirements

    3 180° bends
    3 90° bends





REMEMBER: VERY LITTLE MASS HERE -- DO NOT LINGER;
REDUCE SOLDER DIA. AND TIP TEMP.

CERTIFICATION PROJECT PROCEDURE

RESISTANCE SOLDERING OF CUP TERMINALS

1. Set up resistance soldering unit.

   a. Plug foot switch into wall receptacle.
   b. Plug transformer into foot switch plug.
   c. Press foot switch; light should come on transformer. If not, call instructor.
   d. Take foot off pedal.
   e. Insert either (1) or (2) into transformer.

      (1) Handpiece
      (2) Thermal strippers

2. Set transformer dial for desired output; adjust up or down as required.

3. Strip, tin and clean 6 #20 AWG stranded wires.

NOTE: If thermal strippers are used, a heat induced collar may prevent closing of antiwicking tool. Remove collar or use heat sink.

4. Put cup in right hole of vise held teflon fixture.

   a. Incline cup approximately 45°
   b. Keep cup opening facing you

5. Prepare conductor; cut to desired length.

   a. Use empty cup
   b. Insulation gap referenced from top of cup

6. Prefill cup with solder.

   a. Use .032 or .040 dia solder.
   b. Use trial and error to find right amount.

7. Place electrodes in contact with cup (at bottom of cup cavity).

CAUTION: Never place electrodes on work or take electrodes off work when current is flowing. (arcing may occur).

8. Using other hand, hold prepared conductor above cup opening; use antiwicking tool or heat sink.

9. Press foot switch.

   a. Current will flow through work.
   b. Wait for solder to melt.

10. Insert wire into molten solder:

    a. Wait for cold wire to heat.
    b. Notice solder movement during wetting of heated wire.

11. Remove foot from footswitch.

12. Remove electrodes from cup

13. After solder cools, release wire; avoid fractured joint.

14. Remove flux residue

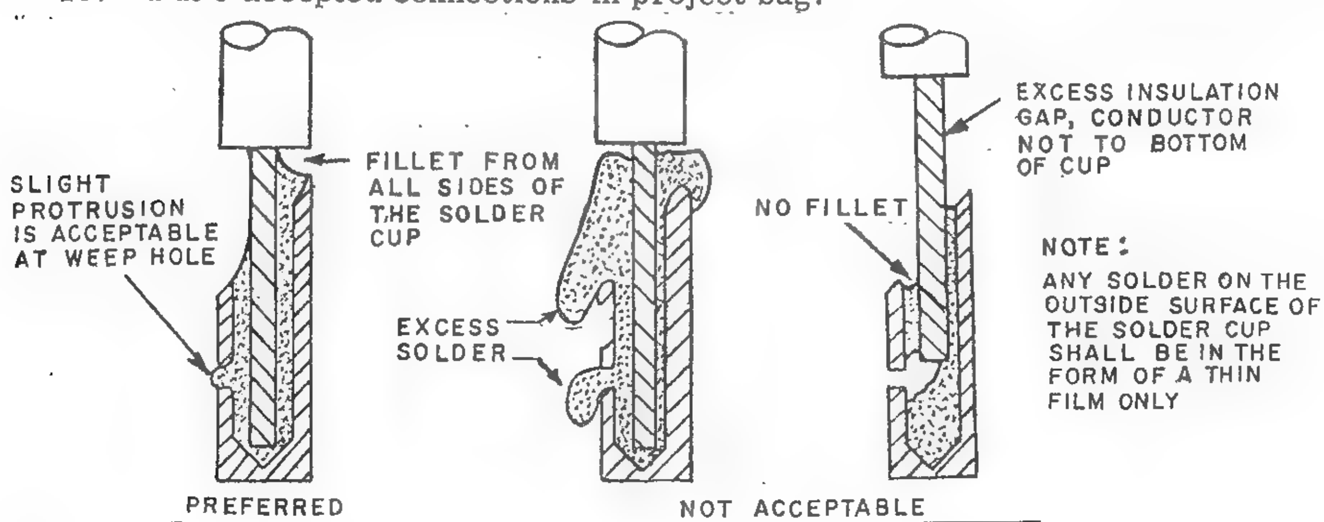
15. Inspect your work for:

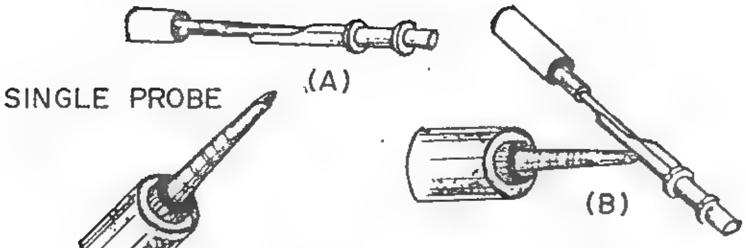
    a. Concave fillets
    b. Contour soldering
    c. Neat, shiny, smooth surfaces
    d. Wicking
    e. Correct insulation gap
    f. Wire correctly placed in cup
    g. Compliance with applicable standards

16. Show instructor only your work that has your approval.

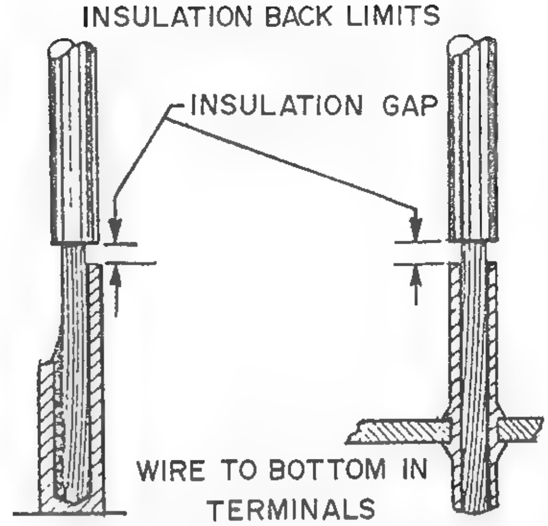
17. Complete 6 acceptable connections.

18. Put 6 accepted connections in project bag.

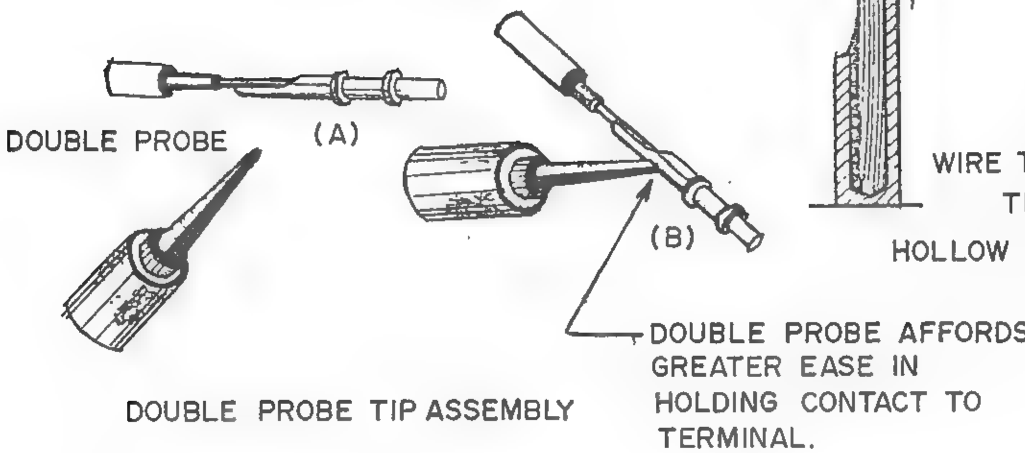




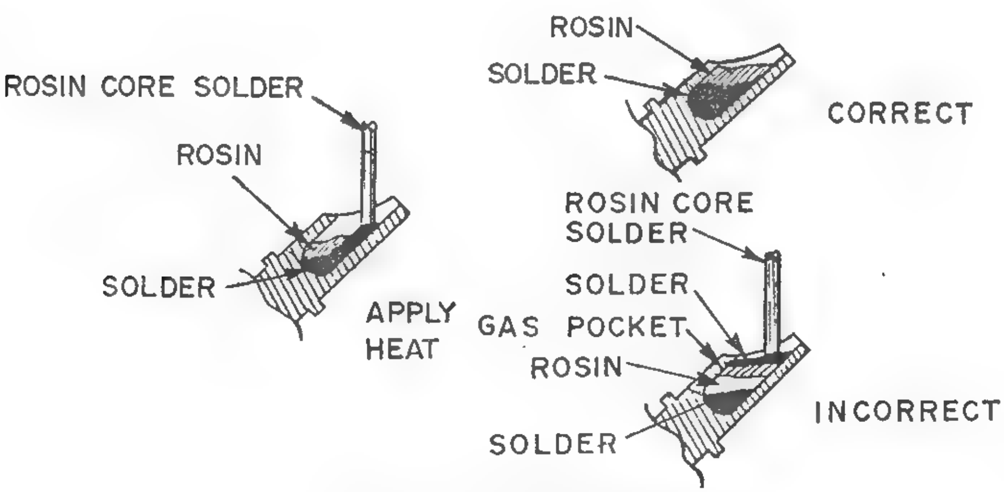
SINGLE PROBE TIP ASSEMBLY



HOLLOW CORE TERMINALS



DOUBLE PROBE TIP ASSEMBLY



PREFILLING SOLDER CUPS WITH CORED SOLDER

INCLINE CUP APPROXIMATELY 60°

RESISTANCE SOLDERING OF CUP TERMINALS

CERTIFICATION PROJECT PROCEDURE

SOLDERING SOLID LEADS TO PRINTED CIRCUIT BOARDS

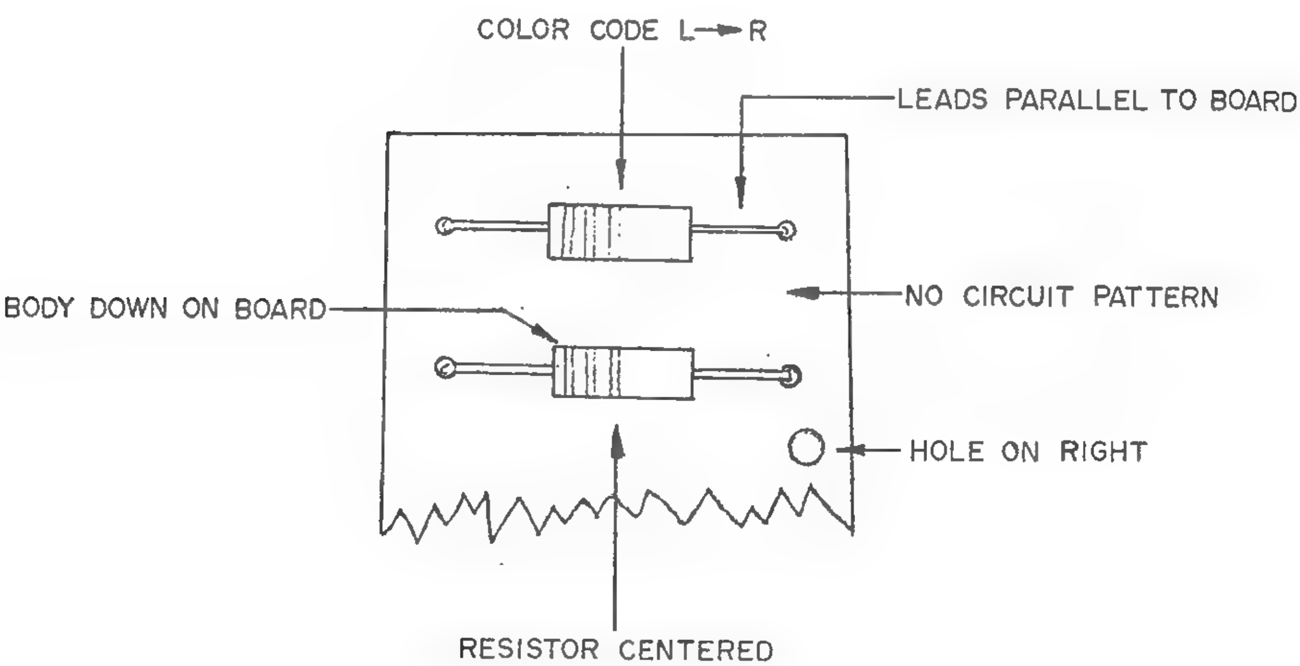
1. Clean and tin all resistor leads.

2. Clean pad areas with:

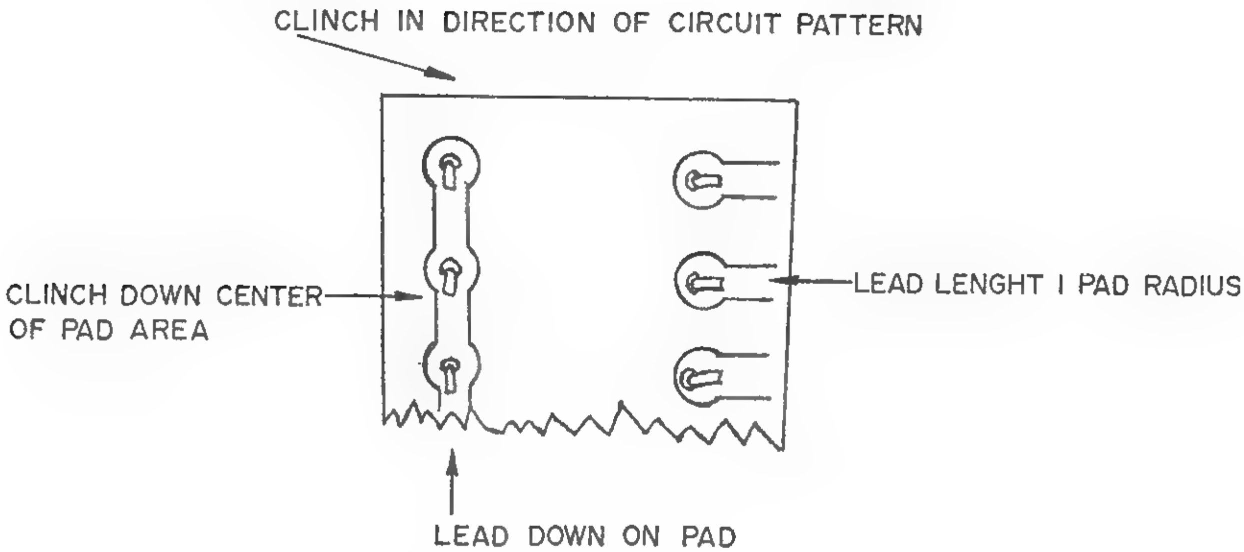
   a. Pencil eraser - oxides
   b. Approved solvent - dirt, grease, residue

3. Form resistor leads; use forming tool.

4. Mount resistors: On side opposite circuit pattern.

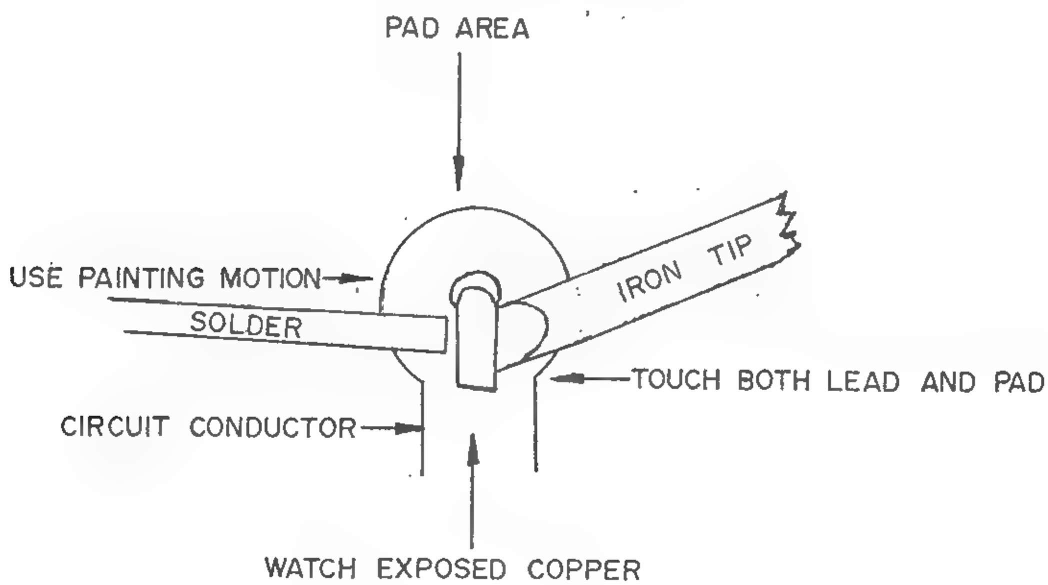


5. Clinch leads:



NOTE: Start clinch with pliers; stop clinch after approximately 60°. Cut off lead 1 pad radius length. Finish clinch with plastic soldering aid.

6. Solder

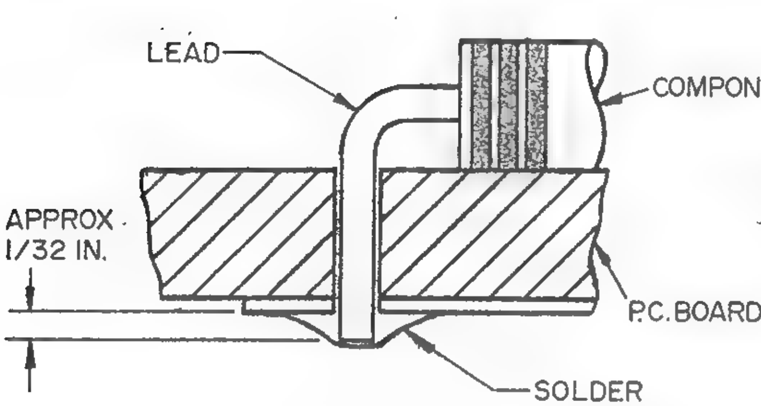


7. Remove flux residue.

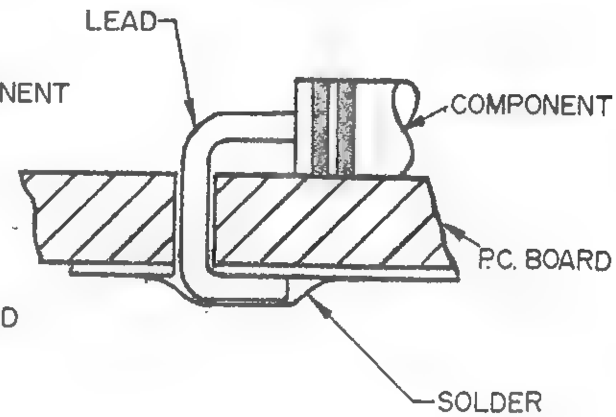
8. Inspect your own work.

9. Call instructor to approve work that has your approval.

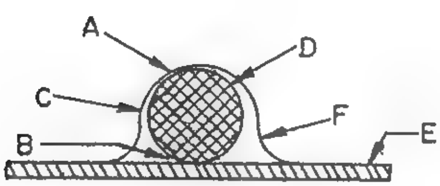
10. Put acceptable work in your project bag.



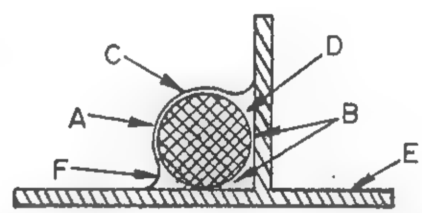
PIN TYPE LEAD



CLINCHED LEAD



PC TYPE SOLDER CONNECTION



SOLID TERMINAL TYPE SOLDER CONNECTION

A. A MINIMUM AMOUNT OF SOLDER SHALL COVER THE TOP OF THE CONDUCTOR.
B. WIRE, SOLDER AND TERMINAL MUST BE COMPLETELY FUSED AT THIS POINT AND WIRE MUST BE ADJACENT TO TERMINAL.
C. ENTIRE MASS CONSISTING OF TERMINAL, WIRE AND SOLDER MUST BE FREE OF ALL FOREIGN SUBSTANCES.
D. CONDUCTOR WIRE (COPPER).
E. TERMINAL OR PRINTED CIRCUIT (PC) PAD.
F. SMOOTH SOLDER CONTOUR AND PROPER FILLETING ACTION INDICATION REQUIRED FLOWING AND WETTING ACTION.

ENLARGED CROSS SECTION OF PROPER SOLDER CONNECTIONS

TOOL BOX & WORK POSITION CHECK LIST

1. Items to be stored in tool box

Quantity	Nomenclature	In	Out
1	Anti-wicking tool #821		
1	Anti-wicking tool, felt tipped		
1	Heat sink, button type		
1	Heat sink, alligator type		
1	Heat sink, single prong		
1	6 inch scale		
1	Pliers, diagonal cutting, 4"		
1	Pliers, round nose, 4"		
1	Lemon stick		
1	Soldering aid, plastic		
1	Brush, medium stiff		
1	Lead cleaning eraser		
1	Magnifier, 4x or 7x		
2	Clothes pins		
1	Eraser, pencil type		
1	Spool, dri-wick		
1	Teflon terminal fixture		
1	Insulation stripper, mechanical		
6	Rubber bands		
3	Toothpicks		
7	*Resistors - 1/4 watt and/or 1/2 watt		
	*Bifurcated terminals		
	*"J" hooks		
	*Cup terminals		
	*PC board		
1	Lead Forming Tool		
1	File, 6 inch, with handle		
1	Brush, Cleaning small arms (FSN 1005-550-4036) (must be ordered thru Armament Command)		

TOOL BOX & WORK POSITION CHECK LIST

2. Items to be stored on work bench

Quantity	Nomenclature	In	Out
1	Resistance soldering transformer w/foot pedal		
1	Resistance soldering probes		
1	Resistance thermal insulation strippers		
1	Solvent dispenser		
1	Hexacon or Weller soldering unit (stand and soldering iron and sponge)		
6	Soldering iron tips		
1	Vise with stand and spring lead holder		
1	Flux dispenser		
4	Solder rolls - .025, .032, .040, .064		
1	Pair safety glasses		
1	Box of kimwipes		
1	Package of lens tissue		
1	Package of lens tissue (FSN 6640-285-4694)		

CERTIFIED SOLDERING NOTES

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Quality Assurance Terms and Definitions:

Defect: Any nonconformance of a characteristic with specified requirements. (Source: MIL-STD-105)

Deviation: Written authorization, granted prior to the manufacture of an item, to depart from a particular performance or design requirement of a contract, specification, or referenced document, for a specific number of units or specific period of time. (Source: DOD-D5010.19)

Nonconformance: The failure of a unit of product to conform to specified requirements for any quality characteristic. (Source: Handbook H53)

Qualification: The entire process by which products are obtained from manufacturers or distributors, examined and tested, and then identified on a Qualified Products List. (Source: Defense Standardization Manual 4120.3-M).

Qualified Product: A product which has been examined and tested and listed on or qualified for inclusion on the applicable Qualified Products List. (Source: Defense Standardization Manual 4120.3-M)

Qualified Product List (QPL): A list of products, qualified under the requirements stated in the applicable specification, including appropriate product identification and test reference with the name and plant address of the manufacturer or distributor, as applicable. (Source: Defense Standardization Manual 4120.3-M)

Quality: The composite of all the attributes or characteristics, including performance, of an item or product. (Source: DOD-D-4155.11)

Quality Assurance: A planned and systematic pattern of all actions necessary to provide adequate confidence that the item or product conforms to established technical requirements. (Source: DOD-D-4155.11)

Quality Assurance Representative (QAR): The individual directly charged with performance of the Government procurement quality assurance function at a contractor facility.

Quality Control (QC): A management function whereby control of quality of raw or produced material is exercised for the purpose of preventing production of defective material. (Source: MIL-STD-109A)

Reliability: The probability that an item will perform its intended function for a specified interval under stated conditions. (Source: MIL-STD-721)

Waiver: A written authorization to accept a configuration item or other designated items, which during production or after having been submitted for inspection, are found to depart from specified requirements, but nevertheless are considered suitable for use "as is" or after rework by an approved method. (Source: DOD-D-5010.19)

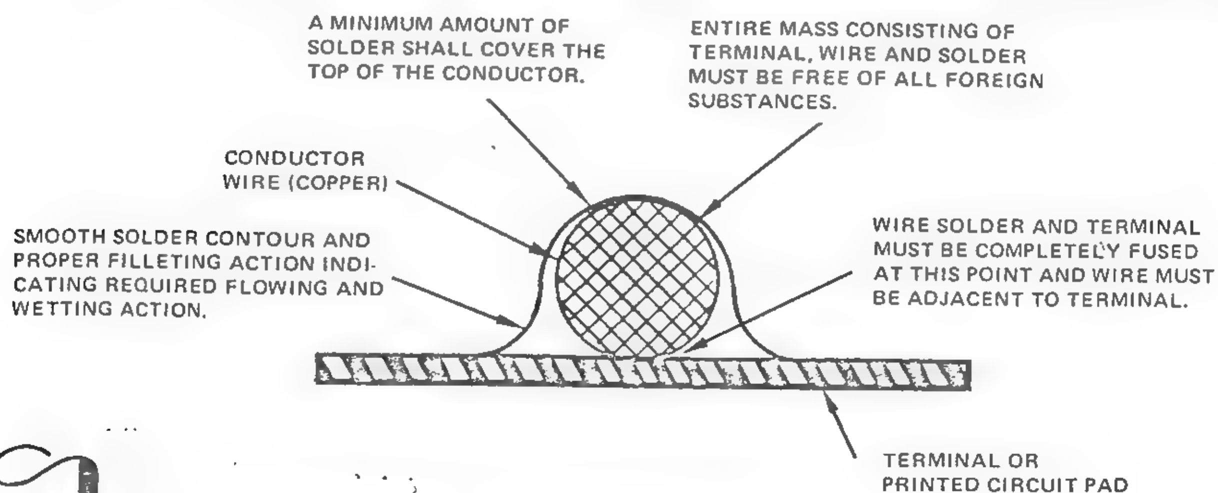
Reliable Solder Connections Include But Are Not Limited To:

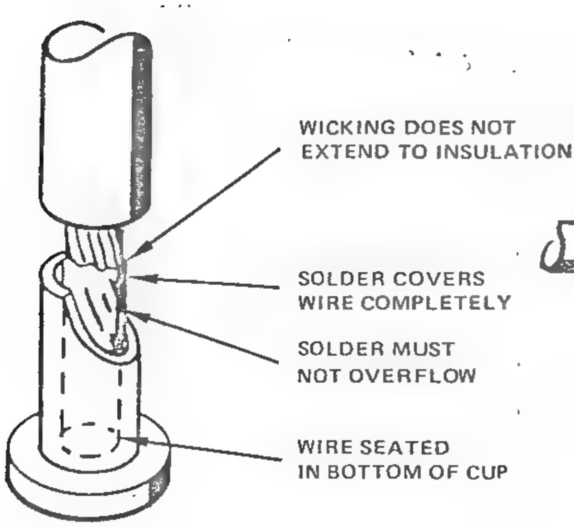
1. Mechanical Strength - Must hold together under required operating conditions.

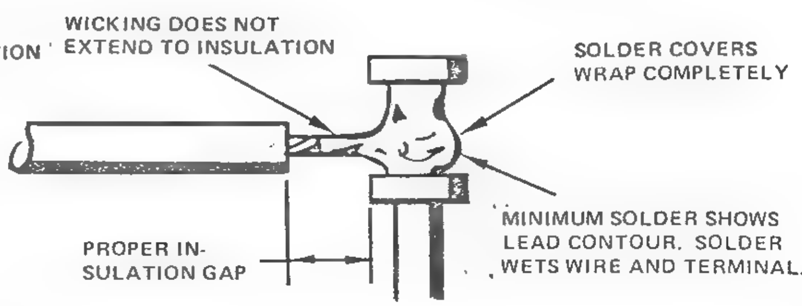
2. Electrical Fidelity - Faithful reproduction of design parameters.

3. Conformance to applicable drawings and/or specifications including but not limited to:

    a. Correct mechanical wraps
    b. Concave fillets between all mating surfaces
    c. Contour soldering
    d. Neatness - no foreign matter
    e. Smoothness - no rough, pourous surfaces
    f. Shininess
    g. Only allowed exposed copper
    h. Sufficient solder - but not excessive
    i. Low contact angles (good solder flow) - good wetting action
    j. Allowed wicking only
    k. Conductor integrity - no nicks, scores, rings, cuts, or scrapes
    l. Insulation integrity - no damage
    m. Disturbed (stress/strain marks), fractured (cracked) joint are to be avoided







Requirements For Reliable Hand Soldering Include But Are Not Limited To:

1. Careful Preparation (getting ready)

   a. Choice and preparation of tools and materials
   b. Precleaning (surface preparation)
   c. Lead or wire preforming and mechanical wraps

2. Adequate Heat

   a. Heat source - iron - wattage - design
   b. Temperature availability - iron tip - (design)
   c. Heat placement - tip contact point
   d. Heat transfer - tip maintenance - solder bridge

3. Correct time

   a. Too little-cold solder joint
   b. Too much-overheated joint

Note: When considering time and temperature needs always remember the following:

1. Time and temperature go hand in hand, either may be varied to correct a heat problem.
2. Heat carried to an area can not cause problems until absorbed by the area.
3. Correct time and/or adequate heat can vary with materials, mass, and heat source used.

4. Skill (how good you are)

   a. Awareness-knowing what is required
   b. Attitude-caring
   c. Ability-technique - use of tools and materials (how you go about it)

5. Post soldering controls

   a. Post cleaning - flux residue and other soil removal - choice of solvent - methods used
   b. Quality controls - inspection and, if needed, effective rework.

Why Use A Paste Solder?

By Dr. Jay Feinberg

Before deciding whether the use of paste solder would be advantageous in your soldering operation, one should obtain a general understanding of what the product is, how it is used, and what advantages it offers over other forms of solder.

To begin, paste solder is just that - solder which is in the form of a paste. (This should not be confused with soldering paste, a paste flux used for soldering.) The paste solder is composed of a flux vehicle and powdered solder alloy which have been blended together to produce a homogeneous blend, the physical and chemical properties of which may be varied considerably as may be required by a particular soldering application.

The solder powder used to make the paste can have a considerable effect on the final properties of the paste. Generally, it is available in two particle sizes - 200 mesh and 325 mesh. Although the 200 mesh powder produces a paste with a coarser or more gritty consistency, it is generally preferred because the larger particles have less surface area and therefore less oxide, and also because these larger particles tend not to float away with the flux and thus produce solder in areas where it is not desired. Even though generally less desirable, the 325 mesh particle range is valuable in those cases where the paste must be pushed through extremely small openings. Typically, this might be where it is being screened through a 150 or 200 mesh screen or being dispensed by syringe through a 19-gauge or finer needle.

The flux vehicle is generally composed of a flux plus a binder which usually is polymeric in nature. The binder acts to give the paste its rheological or flow properties and helps to suspend the solder particles in the flux. The flux may be any of those types which are available as liquids as found in core solder. Although certain special types of fluxes may also be available, the various rosin fluxes (R, MRA, RA), organic water soluble, and inorganic chloride fluxes are the ones finding the most common usage.

The most important rheological property that the consumer of paste solder should concern himself with is that of viscosity. Normally, this property can be varied within fairly wide limits by simply adjusting the solvent content of the flux prior to the manufacture of the paste solder. In addition, by careful and judicious use of a compatible thinner the paste user may also within limits, alter the viscosity to suit his own requirements. It should be pointed out that those who specify a particular viscosity should be careful to indicate not only the centipoise (cps) value of the viscosity magnitude, but in addition should clearly state the conditions under which this value has been obtained. That is, the type of viscometer, the type of spindle, the speed of rotation, and the temperature of the paste (Not just the

(Continued on Page 8)

room temperature) should all be included. Both the vendor of the paste product and the ultimate user should be clear as to what he means when he specifies a particular viscosity, otherwise the viscosity value given by itself will have no meaning at all.

Two methods of applying the paste (by syringe and silk screening techniques) have already been mentioned. In addition to these, several other less frequently used techniques are worthy of mention. Paste may be contact printed through a stencil where a large build up is required, leads may be dipped into paste, pins may dip into a paste reservoir which then deposit the paste which has adhered to the part to be soldered, paste may be painted on by brush, and paste may be deposited by contacting the part to be soldered with a wheel which has been turning in a paste reservoir.

The methods used to melt the paste solder are the same as those used to melt other forms of solder although certain procedures are particularly advantageous to most paste solder applications. That is, ovens (convection or infrared, batch or conveyorized) and hot plates (stationary or conveyorized) are the most common and efficient methods of providing the heating required. In general, to avoid splattering of the paste solder, a preheating zone which raises the paste to a temperature close to but below its melting point should be employed. Then the paste should pass into the melting zone which should be about 50-100 degrees Fahrenheit above the alloy's melting point. Following the soldering operation, the flux residue would be treated in much the same manner as it would following the use of other types of solder and flux.

The primary advantage that paste solder (as a form of solder) offers is the ease with which it may be automated. Dispensed by syringe with air pressure, multiple needle equipment allows multiple "shots" of paste at the same time. With silk screening equipment a complete pattern may be printed with one stroke of a squeegee blade. When compared to time and labor consuming hand soldering methods, paste solder should definitely warrant serious consideration as a means of improving production efficiencies - not to mention quality.

Most often the type of solder which the paste will be considered as a replacement for will be the "solderform" or solder preform. There are several advantages which solder in the paste form has when compared to the use of preforms. (1) Paste can be used where the geometry of the soldered area is difficult to obtain with a preform. (2) Particularly with regard to difficult to handle preforms, paste is easier to automate. (3) With paste there are fewer items to inventory (and possibly misplace). (4) When a manufacturing run is completed, the preform may become obsolete whereas the paste needn't be discarded. In addition, new preforms may require additional tooling costs. (5) As received, the paste is easier to inspect for quality because a small sampling is much more representative of the whole lot than would necessarily be the case with preforms. (6) In many cases, a somewhat milder fluxing vehicle may be employed with the paste than would be needed for the preform because the flux being in intimate contact with the paste solder particles allows it to be more effective in its ability to lower the surface tension of the solder. In addition, the volume of flux is also much greater in the paste adding to its ability to provide good fluxing action.

In conclusion, paste solder has been receiving ever increasing attention, particularly for electronic applications because of its ease of being automated and low level of wastage due to its adaptability from one manufacturing run to another.

PRACTICAL EXERCISE ASSIGNMENT

	Stripping & Tinning	Turrent Terminals	Bifurcated Terminals	Hook Terminals	Cup Terminals	PC Board
Project Manager						
Prep Time						
Inspector						
Student Inspectors						
Visual Aid Development Instructors						
Visual Aid Development Inspectors						
Operators						

Projects: Tools: Required: ____________ Date: ________

	MIL-S45743E	MIL-STD-1460	Comments
Stripping			
Tinning			
Lead Bending			
Gen/Info Mechancial Attachment			
Solder Application			
Cleaning			
Visual Inspection of Workmanship			